AD-A155 156 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS WATER LOOM POND DAM (.. (U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV FEB 79 1/1

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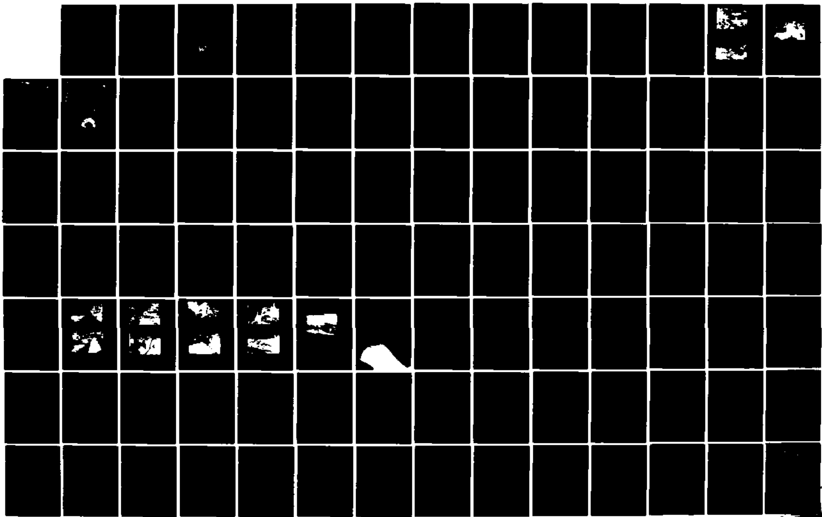

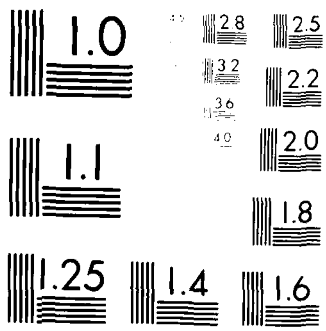

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MERRIMACK RIVER BASIN
NEW IPSWICH, NEW HAMPSHIRE

WATER LOOM POND DAM
NH 00355
NHWRB 175.09

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

FEBRUARY 1979

UNCLASSIFIED

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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
New Ipswich, New Hampshire
Souhegan River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a 204 ft. long earth fill, concrete gravity and stone masonry structure on the Souhegan River. It is about 22.5 ft. high with its 75 ft. long spillway having a height of about 19 ft. It is small in size with a significant hazard potential. The dam is in poor condition and requires considerable routine maintenance. There are various remedial measures which must be implemented by the owner.

DISCLAIMER NOTICE

WATER LOOM POND DAM
NH 00355

MERRIMACK RIVER BASIN
NEW IPSWICH, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

PHASE I REPORT

Identification No.:	NH 00355
NHWRB No.:	175.09
Name of Dam:	WATER LOOM POND DAM
Town:	New Ipswich
County and State:	Hillsborough County, New Hampshire
Stream:	Souhegan River
Date of Inspection:	November 14, 1978

BRIEF ASSESSMENT

Water Loom Pond Dam is a 204 foot long earth fill, concrete gravity, and stone masonry structure on the Souhegan River in New Ipswich, New Hampshire. The total dam height is about 22.5 feet with its 75 foot long spillway having a height of about 19 feet. A sluice gate at the right abutment is no longer operable while a former outlet to a six foot penstock has been filled in with earth. The dam is presently owned by Warwick Mills. Some sort of dam has probably existed on the site since about 1827.

The dam was used to supply power to various mills downstream of the dam, but it is not presently being used to supply power. The drainage area is 23.1 square miles of primarily forested terrain. The dam's maximum impoundment of less than 1000 acre-feet and height of less than 40 feet place it in the SMALL size category, while the possibility of damage to downstream structures in the event of a failure with little threat of loss of life result in a SIGNIFICANT hazard potential classification. Based on the size and hazard classification, and in accordance with the Corps' guidelines, the Test Flood (TF) is taken as the 100-year flood.

A TF at the dam of 4000 cfs was chosen. This discharge corresponds to a water level of 4.9 feet above the spillway crest or about 1.4 feet above the left side of the dam.

The dam is in POOR condition and requires considerable routine maintenance. It is recommended that the owner retain the services of a registered professional engineer to rehabilitate the sluice gate structure and restore it to operating conditions; to repair eroded and spalled concrete on all facing walls, abutments, and at the spillway base; and to monitor seepage at the penstock and right abutment structure to determine necessary remedial

measures. Recommended remedial measures include clearing of brush and trees on downstream slopes, completely severing the penstock at its emergence through the downstream side of the dam, instituting a program of annual technical inspections, clearing debris and overhanging trees from the downstream channel, and preparing a formal flood and emergency warning system.

The recommendations and improvements outlined above should be implemented within one year of receipt of the report by the owner.

THE STATE OF NEW HAMPSHIRE
WILLIAM S. ZOLNO
REGISTERED PROFESSIONAL ENGINEER

REGISTERED PROFESSIONAL ENGINEER
NICHOLAS ANTHONY CAMPAGNA, JR.
No. 21,006
CIVIL
STATE OF CALIFORNIA

William S. Zolno
N.H. Registration 3226

Nicholas A. Campagna, Jr.
California Registration 21006

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can unsafe conditions be detected.

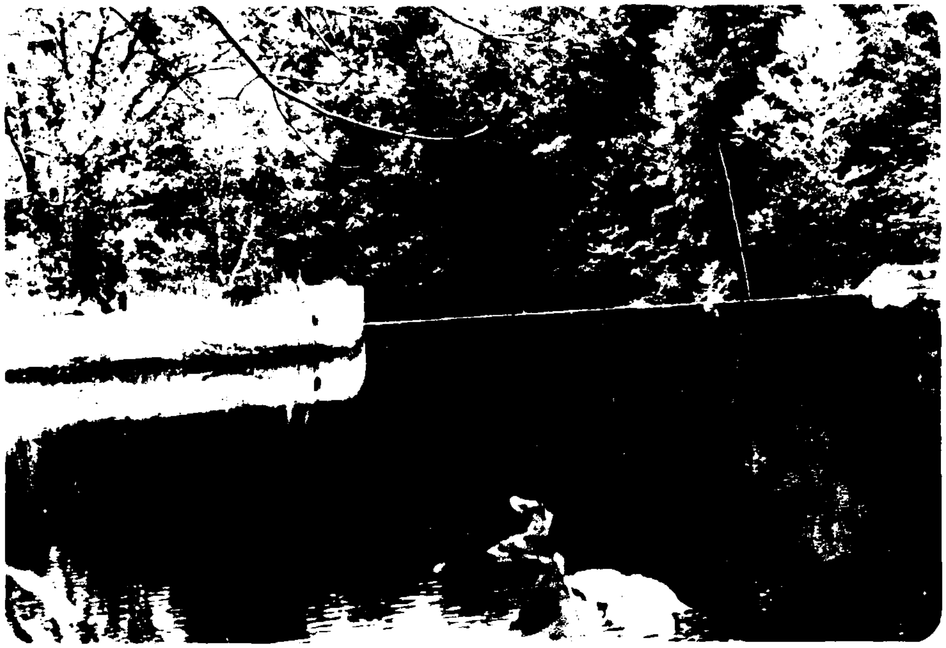
Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the Test Flood should not be interpreted as necessarily posing a highly inadequate condition. The Test Flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

TABLE OF CONTENTS

Table of Contents - Cont.


Overview of left side of dam and abandoned inlet from upstream left side


Overview of dam from right abutment



Overview of spillway from upstream left side

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedure

At present the dam is not operated. Water flows in an uncontrolled manner over the spillway. None of the control facilities is operable.

4.2 Maintenance of Dam

The dam is not being maintained. The poor condition of the concrete at the dam is direct evidence of this.

4.3 Maintenance of Operating Facilities

The old penstock outlet has been sealed with earth fill, and the sluice gate has not been maintained and is no longer operable.

4.4 Description of Warning System

No warning system is in effect for this dam.

4.5 Evaluation

The dam's present POOR condition is a direct result of the lack of maintenance of the dam and its facilities. The severe deterioration of the concrete on the spillway, abutment structures and facing walls is an example of this. The sluice gate is not operable because of the lack of maintenance.

Failure of this steel riveted penstock at this location could possibly cause translation and rotation of the penstock through the earth embankment. Seepage at the rate of 1 gpm was observed through the penetrated invert.

3.2 Evaluation

Water Loom Pond Dam is rated in POOR condition based primarily upon the deteriorated condition of the concrete. The concrete facing for the earth embankment on the left side of the dam is severely eroded as it is on other parts of the dam. In general, the dam's major components are efficiently accessible to permit a satisfactory visual inspection.

Seepage at the rate of 1 gpm flows through the interface of the downstream base of the structure and bedrock.

(6) Gate Structure

This gate is no longer operable. Observations have revealed that the timber sluice gate has deteriorated to the extent that seepage flows through and around the gate. This seepage is at the rate of approximately 15 to 20 gpm. In addition, the timber gate stem is broken and rotted and the operating mechanism is rusted with no evidence of maintenance.

The concrete in the roof of the sluiceway outlet structure is severely exuded and has significant stalactite formation. Both side walls of this structure are highly effloresced. The base of the walls of this structure are spalled and deteriorated. A detailed inspection of the extreme deterioration of the upstream face of this structure has revealed that this structure was constructed with random stone masonry and later faced with concrete. Dislodged stones observed below water level would preclude the operation of the sluice gate.

(7) Right End Wall

The top surface of this structure is spalled and is randomly cracked over its entire area. The upstream face is also severely spalled. This spalling is attributed to moisture intrusion and the action of alternate freeze and thaw cycles.

(8) Penstock

Failure of the supporting piers carrying the penstock over the outlet channel would conceivably increase the rate of seepage through the earth embankment and become a potential hazard. Observations have revealed that the penstock freely spans over the abandoned foundation wall and then over two piers spanning the outlet channel. The right pier, which is approximately 10 feet high, is out of plumb by approximately 6 inches.

(3) Left Spillway Abutment and Downstream Training Wall

Approximately 25% of the top surface area of the left abutment has spalled. The vertical surface of this wall is extensively spalled and deteriorated over 50% of its surface area. The intersection between the abutment's vertical plane with the spillway crest has eroded along the contour of the crest for a distance of approximately 4 feet. The depth of the erosion is up to 6 inches. This erosion is attributed to ice damage and cavitation. The left downstream training wall has a series of horizontal cracks and points of efflorescence. The randomly placed stone masonry training wall does not have any visual deficiencies.

(4) Spillway Structure

Inspection of the downstream face of the spillway structure revealed that there are a series of open construction joints with minor evidence of erosion, which is attributed to cavitation. However, there are two areas where erosion is severely pronounced. These areas are located at the spillway center and right quarter point of the spillway base. The eroded concrete at the center of the spillway is approximately 8 feet long, 2 feet high, and 6 inches deep. The erosion at the quarter point is approximately 8 square feet in surface area and approximately 3 inches deep. The erosion at these two locations is attributed to cavitation of improperly mixed concrete.

(5) Right Abutment Structure

This structure is severely eroded and spalled. The upstream side of this structure has been eroded to depths of 15 inches at the spillway crest elevation, exposing rubble stone masonry from previous constructions. This erosion continues along the interface of the structure and the ogee crest and is about 9 to 12 inches in depth. The vertical faces of the structure are spalled from a depth of approximately 4 inches below the water line to near the top surface of the structure. The erosion and spalling is attributed to ice damage, cavitation, and alternate freeze and thaw cycles. Random cracking and efflorescence is prevalent over the vertical and horizontal surfaces of this structure. A close inspection of this structure has revealed that concrete topping and facing repairs had been instituted in the past which accounts for the uniform depth of spalling.

SECTION 3 - VISUAL OBSERVATIONS

3.1 Findings

(a) General

Water Loom Pond Dam is in POOR condition. This evaluation is based primarily on the deterioration of various structural components of the dam. This structure requires extensive maintenance type repairs to allow its continued long-term use.

(b) Dam

(1) Left Facing Wall

The front face of this wall has spalled or eroded over its entire length. In some cases, the erosion is 2 feet high and 12 inches deep. Immediately to the left of the first angle point of this wall the erosion and spalling of the face of the wall is in excess of 4 feet in height and 6 inches deep at the water line. Reinforcing steel is exposed in this area. Reinforcing steel is also exposed over approximately 25% of the length of the wall at the spillway crest elevation. The section of the wall adjacent to the abandoned outlet structure, which is approximately 15 feet long, exhibits erosion over two thirds of its face. This erosion is to a depth of 4 or 5 inches. The top surface of the entire wall has spalls over approximately 5% of its area and has much random cracking. The erosion and spalling along the entire face of this facing wall is attributed to wave action, ice damage, and alternate freeze and thaw cycles.

The entrance opening to the penstock has been blocked off with wood planking and earth backfill within the training walls. The penstock gate is no longer operable. Minor seepage at the rate of 1 gpm was observed through the invert opening of the penstock adjacent to the abandoned building foundation wall.

(2) Left Earth Embankment

The earth embankment on the downstream side of the left facing wall shows no evidence of vertical or horizontal movement. The downstream slope is covered with heavy brush and a few trees. This makes inspection of the slope difficult. This slope should be inspected again after the trees and brush have been cleared. There was no evidence of trespassing on the slopes.

SECTION 2 - ENGINEERING DATA

2.1 Design Records

The design of the dam is not complex and incorporates no unusual features. No design drawings or calculations of value were available for this dam.

2.2 Construction Records

No construction records are available for the dam.

2.3 Operational Records

No operational records of value are available for the dam.

2.4 Evaluation of Data

(a) Availability

The absence of any meaningful design data and calculations leads to an unsatisfactory assessment for availability.

(b) Adequacy

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is based primarily on the visual inspection, past performance, and sound engineering judgment.

(c) Validity

The observations of the inspection team generally confirm the information contained in files of the New Hampshire Water Resources Board. Therefore, although the data is very limited, a satisfactory evaluation for validity is indicated.

(4) Spillway crest: 927.7

(5) Invert of sluice gate (inoperable): 921 ±

(6) Streambed at low point: 908.9 ±

(d) Reservoir

(1) Length of pool - recreational: 8300 feet ±
- maximum: 10,100 feet ±

(2) Storage - recreational pool: 420 acre-feet ±
- maximum pool: 665 acre-feet ±

(3) Surface area - recreational pool: 70 acres ±
- maximum pool: 75 acres ±

(e) Dam

(1) Type: Earthfill embankment with a concrete facing and a gravity concrete spillway

(2) Length: 204 feet ±

(3) Height: 22.5 feet

(4) Top Width: Varies

(5) Side Slopes: Vary

(f) Spillway

(1) Type: Ogee gravity concrete

(2) Length of weir: 75 feet

(3) Crest elevation: 927.7

(4) Gates: None operable

(5) U/S channel: Wide approach from pond

(6) D/S channel: Rocky river channel with overhanging vegetation

(g) Regulating Outlet

See Section 1.3 (b) (1) of this report.

(i) Normal Operational Procedure

No operation is performed at the dam. Water flows over the spillway in an uncontrolled manner.

1.3 Pertinent Data

(a) Drainage Area

Water Loom Pond receives runoff from 23.1 square miles of primarily steeply sloping forested terrain. Developing areas comprise only a small portion of the drainage area.

(b) Discharge at Damsite

(1) Outlet Works

The outlet works consist of a 16 foot wide inlet that used to supply the 6 foot penstock that led to the mills downstream and a grated sluiceway approximately 3 feet wide by 3 feet high. Neither of these outlet works is presently operable.

(2) Maximum Flood

The flow during the storm of March 1936 evidently exceed 5000 cfs. It should be noted, however, that since that time a number of flood control dams have been built on tributaries to the Souhegan River, including at least two upstream of Water Loom Pond.

(3) Spillway capacity at maximum pool elevation:

1950 cfs at El. 931.2 (This includes some flow - 110 cfs over the right side of the dam)

(c) Elevation (Feet above MSL)

(1) Top of dam: 931.2

(2) Maximum pool: 931.2

(3) Recreational pool: 927.7

(d) Hazard Potential Classification

Water Loom Pond Dam is considered to fall within the SIGNIFICANT hazard potential classification. This is based mainly on the possibility of some damaging flooding in downstream Greenville and also the remote possibility of damaging Otis Company Dam No. 1 (NH 00041) downstream. The potential for loss of life in the event of a dam failure is considered remote.

(e) Ownership

Columbia Manufacturing owned the mills and dam from 1838 until they went bankrupt in 1924 at which time they sold their holdings to Consolidated Textiles. Consolidated Textile closed the mills and dam. In 1936 Warwick Mills purchased the dam and several mills and still owns the dam. Their address is Warwick Mills, Greenville, New Hampshire.

(f) Operator

Warwick Mills operates the dam through its plant manager, Mr. Roger Laferrier. He can be reached by telephone at 603-878-1565.

(g) Purpose of Dam

The original purpose of the dam was to provide power for the mills downstream from the dam. At present there is no readily identifiable purpose for the dam although it may serve some recreational purpose in this rural location. The last power was generated in the mid 1960's.

(h) Design and Construction History

The dam was built in conjunction with mill construction. The first mill was built in 1827 and burned in 1848. The second mill was built in 1849 and burned in 1871. The third mill at the site was built in 1878. No data is available on when the original dam was built, but it was probably built in conjunction with the original mill. Data supplied by Mr. Laferrier indicated that the dam was rebuilt in 1840 and that concrete was added to the structure in 1948-1949. Other data suggests that modifications in 1925 and 1930, which consisted of facing the abutments with concrete, shortened the spillway by about 10 feet.

The upstream face of the earth-filled dam has a concrete facing. The width at its top surface varies from 15 inches to 2 feet. A dry stone masonry wall is located approximately 15 feet downstream and is parallel to this concrete facing. The right end of this wall is stone masonry and forms part of the left end of the spillway.

The left end wall of the spillway consists of a squared stone masonry structure approximately 10 feet wide and is partially buried on its downstream side. The front face of this end wall consists of a 4 foot wide cement concrete structure. The downstream training wall is approximately 10 feet wide, 30 feet long, and is constructed with squared stone masonry. A concrete apron approximately 8 feet square is located at the downstream base of this end wall.

The spillway is approximately 19 feet high at its maximum and is founded on bedrock. The crest of the spillway is approximately 3.5 feet below the top of the left side of the dam. There are no provisions for flashboards along its crest.

The right abutment structure is a concrete-faced stone masonry structure 11 feet in width and approximately 15.5 feet in length. Its top elevation is approximately one foot lower than the left side of the dam. The downstream end of the abutment structure is 5 feet in width and approximately 17 feet in length. This structure is founded on bedrock. A gate structure with a 3.5 foot by 32 inch sluiceway opening is located to the right of the abutment structure. An end wall, which is parallel to the spillway axis and approximately 26 feet long and 5 feet wide, extends from the side of the abutment structure to the right bank. This wall is founded on bedrock. The sluiceway outlet has been cut through bedrock and diverts the flow back into the downstream channel below the spillway. The sluice gate structure consists of a 3 foot square timber gate and a timber stem with a single rack gear. The rack gear is operated by a spindle gear which is manually driven by a ratchet.

(c) <u>Size Classification</u>

The dam's maximum impoundment of 665 acre-feet is less than 1000 acre-feet and its height of 22.5 feet is less than 40 feet. This places the dam in the SMALL category according to the "Recommended Guidelines" of the Corps of Engineers.

1.2 Description of Project

(a) Location

Water Loom Pond Dam lies on the Souhegan River in the town of New Ipswich, N.H. The dam is located approximately 3000 feet upstream from the crossing of Routes 123 and 124 over the Souhegan River in New Ipswich. The dam is accessible from River Road which intersects Routes 123 and 124 near the center of New Ipswich. The portion of the USGS Ashley, MA-NH quadrangle presented previously shows this locus. Figure 1 of Appendix B presents a detail of the site developed from the inspection visit and the map.

(b) Description of Dam and Appurtenances

The dam and appurtenances consist of a concrete-faced earth embankment, a concrete ogee type spillway, a sluice gate, and an abandoned penstock outlet. The penstock leads downstream to the location of a former mill building and then downstream for a distance of approximately 1.2 miles to other mills.

The overall length of the dam is approximately 214 feet. Approximately 102 feet of this length is left of the spillway. The spillway itself is approximately 75 feet in length. The remaining portion of the dam consists of the right end wall of the dam.

A former outlet structure is located at the extreme left end of the dam adjacent to the left bank. This outlet structure consists of dry stone masonry training walls forming an entrance bay which has since been filled in with earth. Observations of the remains of the mill foundations immediately downstream have revealed the presence of two stone arches in its walls which indicates the presence of a former sluiceway. It is apparent that the abandoned outlet was the source of the water supply to the former mill building. At a later date a 6 foot diameter steel riveted penstock was placed in the former sluiceway and the trench was filled. A gate stem is located at the former outlet which controlled the flow of water into the penstock.

PHASE I INSPECTION REPORT

WATER LOOM POND DAM

SECTION 1

PROJECT INFORMATION

1.1 General

(a) Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZD) has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed was issued to GZD under a letter of November 28, 1978 from Colonel Max B. Scheider, Corps of Engineers. Contract No. DACW 33-79-C-0013 has been assigned by the Corps of Engineers for this work.

(b) Purpose

(1) Perform technical inspection and evaluation of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

(2) Encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams.

(3) Update, verify, and complete the National Inventory of Dams.

(c) Scope

The program provides for the inspection of non-federal dams in the high hazard potential category based upon location of the dams and those dams in the significant hazard potential category believed to represent an immediate danger based on condition of the dam.

- SCALE -

0 1/2 1 2 MILES

FROM: USGS PETERBOROUGH, N.H. QUADRANGLE MAP

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC. GEOTECHNICAL CONSULTANTS NEWTON UPPER FALLS, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

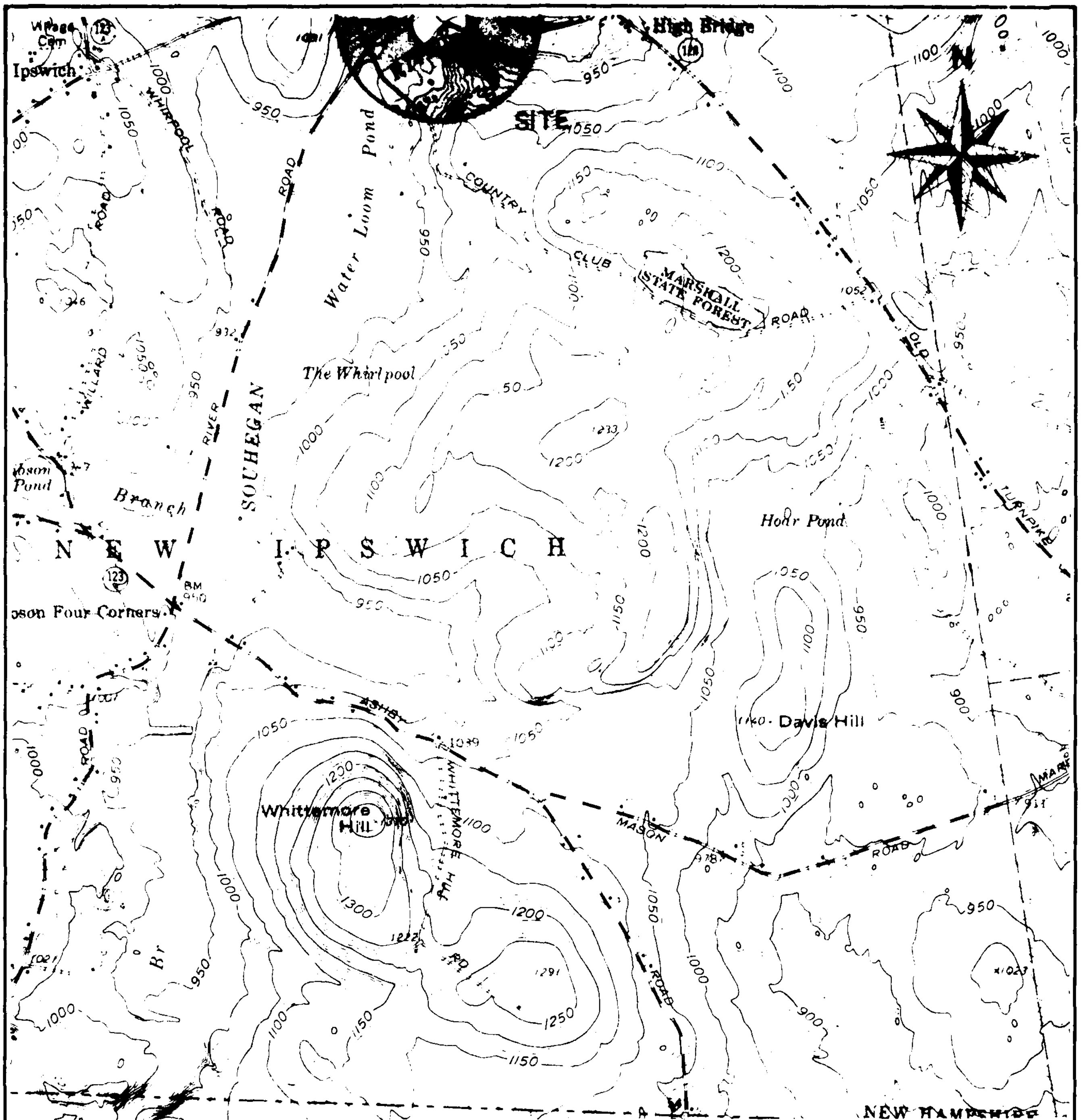
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCUS PLAN

FILE No. 2201

WATER LOOM POND DAM NEW HAMPSHIRE

			SCALE AS NOTED
			DATE JANUARY 1979



– SCALE –

0 1000 2000 4000 FT

FROM: USGS ASHBY, N.H.-MASS QUADRANGLE MAP

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCUS PLAN

FILE No. 2201

WATER LOOM POND DAM NEW HAMPSHIRE

SCALE AS NOTED

DATE NOVEMBER 1978

SECTION 5 - HYDRAULICS/HYDROLOGY

5.1 Evaluation of Features

(a) Design Data

Data sources available for Water Loom Pond Dam include prior inventory and inspection reports. The New Hampshire Water Control Commission's "Data on Dams in New Hampshire" (April 17, 1939), "Data on Reservoirs and Ponds in New Hampshire" (undated), and "Data on Water Power Developments in New Hampshire" (April 17, 1939) as well as the New Hampshire Water Resources Board's "Inventory of Dams and Water Power Developments" (October 29, 1937) provide much of the basic data for the dam. Inspection reports from June 26, 1930, July 3, 1951, and September 24, 1974, a series of undated Water Power Questionnaires and a "Report upon (the proposed) Water Loom Pond Storage Project" (March 1, 1935) by the Advisory Committee on Conservation are also available.

(b) Experience Data

Data on lake levels in Water Loom Pond is available in the U.S. Geological Survey (USGS) Water Supply Papers 798 and 867, which report peak flood levels experienced during major storms in March, 1936 and September 1938; and a Water Control Commission questionnaire completed by the dam's owners concerning the 1938 event. The USGS reports peak levels 5.7 feet and 2.9 feet above the spillway crest in 1936 and 1938. The owners of the dam estimated the peak in 1938 to be about 4 feet above the spillway.

Estimates of peak discharges for the two floods at Greenville, about 1.8 miles downstream, are published in the Water Supply Papers referred to above. The 1936 estimated peak was 6160 cfs and the 1938 value was 4970 cfs.

(c) Visual Observations

Water Loom Pond Dam is a concrete, earth fill, and stone masonry structure on the Souhegan River at New Ipswich, New Hampshire. The spillway is of mass concrete with an ogee-shaped crest. The crest length is 75 feet at elevation 927.7 feet above Mean Sea Level (MSL). A concrete gravity wall extends to the right of the spillway for a distance of about 38 feet with top elevation

2.5 feet above the spillway crest. To the left of the spillway an earthfill embankment, retained by a concrete wall on the upstream side and by a squared stone masonry wall on a portion of the downstream side. The top of the left side of the dam is at elevation 131.2 feet above MSL.

Other dam appurtenances include a sluiceway and a penstock. The sluiceway, just to the right of the spillway, has dimensions approximately 3 feet by 3 feet. It is sealed by a gate which is presently inoperable. The 6-foot diameter steel penstock is no longer in service and has been cut at the site of an old mill (since demolished) just below the dam. The 16-foot wide penstock inlet near the left abutment is sealed with sand and gravel.

Downstream of the dam, the Souhegan River channel is relatively steep and narrow. The penstock is elevated to cross the stream channel shortly downstream of the spillway. About 3000 feet further downstream, the river is crossed by High Bridge. This is a cemented stone masonry structure approximately 25 feet thick and extending upwards perhaps 50 feet above the streambed. The stream passes through a rectangular-shaped culvert with an arched top of dimensions approximately 11.6 feet wide by 23 feet high.

About 600 feet downstream of High Bridge, a small concrete over flow structure has been built across the stream, backing up water to a depth of about 10 feet at High Bridge. There is an operating mill building adjacent to the dam approximately 12 feet above the crest level.

Below this structure, the Souhegan River enters a low, flat swampy area, over a half mile long and over a quarter mile across. The stream then reenters a narrow channel for about a half mile before entering a small, seven-acre, impoundment behind the Otis Company Dam in Greenville. This dam, located in the center of the town, is a 26-foot high masonry structure.

(d) Overtopping Potential

The hydrologic conditions of interest in this Phase I investigation are those required to assess the dam's overtopping potential and its ability to safely allow an appropriately large flood to pass.

This requires using the discharge and storage characteristics of the structure to evaluate the impact of an appropriately-sized Test Flood. None of the original hydraulic and hydrologic design records are available for use in this study.

Guidelines for establishing a recommended Test Flood based on the size and hazard classifications of a dam are specified in the "Recommended Guidelines" of the Corps of Engineers. The appropriate Test Flood for a dam that is SMALL in size with a SIGNIFICANT hazard potential would be between the 100-year flood and one-half of the Probable Maximum Flood (PMF). Where a range of values is indicated for the Test Flood, the magnitude should be related to the hazard potential. Since the hazard potential is on the low side of the SIGNIFICANT category, the test inflow to Water Loom Pond is taken to be the 100-year flood.

As there is no streamflow record or previous study available for this site, the magnitude of the 100-year flood has been estimated using the regression relations developed by Denis R. LeBlanc in the USGS publication, Progress Report on Hydrologic Investigations of Small Drainage Areas in New Hampshire. By this method, the 100-year peak inflow is estimated at 2230 cfs.

Additionally, a 1978 FIS study by ANCO estimated the 100-year and 500-year peak discharges at Greenville, approximately 1.8 miles downstream, to be 1885 cfs and 3600 cfs respectively.

Historic floods at the site have also been considered. The flow during the storm of March 1936 evidently exceeded 5000 cfs, while contradictory evidence for the September 1938 flood indicates that the peak discharge may have been as high as 4100 cfs or it may have been no greater than 1500 cfs. It should be noted, however, that since the time of these floods, a number of flood control dams have been built on tributaries to the Souhegan River, including at least two upstream of Water Loom Pond.

Given the wide range of flood discharge vlues under consideration, an appropriately conservative Test Flood magnitude of 4000 cfs was chosen.

The Test Flood of 4000 cfs is taken to be the value at the dam as modified by flow through the storage in Water Loom Pond. Although no direct storage routing is considered, a storage-stage curve is developed assuming that storage above the full dam level is equal to the lake area times the depth of surcharge. No spreading or increase of area with depth is considered.

The stage-discharge curve is developed by defining discharge as the sum of flow over the spillway, flow over the dam crest, and flow over the side slopes at the ends of the dam. The calculations determining these curves are included in Appendix D.

The peak test discharge of 4000 cfs would result at a maximum stage of 4.9 feet above the spillway crest, or 1.1 feet above the top of the dam (left side).

5.2 Hydrologic/Hydraulic Evaluation

The results of the hydrologic and hydraulic calculations indicate that the dam would be slightly overtopped for the recommended Test Flood. A potential depth of overtopping of 1.1 feet is indicated. It should perhaps be noted here that the dam has previously been overtopped by a greater depth in 1936 without sustaining serious damage. It is uncertain if the dam is in an equivalent state of repair at this time.

5.3 Downstream Dam Failure Hazard Estimates

The peak outflow at Water Loom Pond Dam that would result from dam failure is estimated using the procedure suggested in the Corps of Engineers New England Division's April 1978 "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs." Failure is assumed to occur as soon as the dam crest is overtopped at an elevation of 131.2 feet. This is 3.5 feet above the spillway and some 22 feet above the streambed. It is assumed that a 30 foot gap is opened in the dam - the peak failure outflow through this gap and over the spillway would be 5400 cfs.

This flow would not be significantly attenuated along the reach from the dam to High Bridge for the channel is relatively steep and narrow. Flow depths of about 8.5 feet would be expected, but there are no operating structures along this reach to be endangered.

At High Bridge, the 11.6 foot by 23 foot culvert would act to constrict the high flow and cause backwater ponding immediately upstream. It is estimated from calculations

essentially following the Corps of Engineers guidelines that temporary storage upstream of High Bridge would attenuate the flood peak to 4800 cfs. The estimated peak flood level at High Bridge of 30 feet above the streambed (some 20 feet below the roadway) is not considered a hazard to the structures since it appears that flows of this magnitude have occurred in the past.

The small concrete overflow structure downstream of High Bridge would probably not be adversely affected by the dam failure flood wave. Neither would it impound a large enough volume of water to significantly reduce the peak. At 4800 cfs, the estimated overflow head of 8.3 feet would leave peak flood levels about 4 feet below the level of the nearby mill building.

Further downstream, the flood wave would be significantly attenuated in passing through the flat, swampy area because of the large potential for temporary storage there. It is assumed that the peak flow rate would be reduced in this reach from 4800 cfs to about 4000 cfs. Assuming minimal attenuation in the narrow channel beyond the swamp and in the small impoundment behind Otis Company Dam, the peak discharge at Otis Company Dam because of the hypothesized failure of the Water Loom Pond Dam is estimated at 4000 cfs.

To pass this 4000 cfs flow, the head above the spillway crest must be about 5.5 feet. In this case, a portion of the dam to the left of the spillway will be overtopped to a depth of 1.7 feet while the left abutment will be overflowed to a depth of 0.7 feet causing some damaging, but probably not dangerous, flooding in the town of Greenville. The consequences of such flood depths at the Otis Company Dam are uncertain. Failure of this dam could be very serious because of its location in a built-up area; however, a Water Control Commission questionnaire completed by the dam's owners on October 11, 1938 indicates that a reported flood depth about 5 feet above the spillway crest caused no injury to the dam.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

(a) Visual Observations

The field investigation revealed no significant displacements and/or distress which would warrant the preparation of structural stability calculations based on assumed sectional properties and engineering factors.

(b) Design and Construction Data

No plans or calculations of value to a stability assessment are available for this dam.

(c) Operating Records

There are no operating records for this dam.

(d) Post Construction Changes

There are no records of past construction changes or alterations, but field investigations have revealed that extensive concrete work has been performed on the wall on the left bank, both abutment structures, the sluice gate structure, and the right end wall.

(e) Seismic Stability

The dam is located in Seismic Zone No. 2 and in accordance with recommended Phase I guidelines does not warrant seismic analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

(a) Condition

Water Loom Pond Dam is in POOR condition at the present time. The spillway is in FAIR condition.

(b) Adequacy of Information

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is based primarily on the visual inspection, past performance, and sound engineering judgment.

(c) Urgency

The improvements described herein should be implemented by the owner within one year of receipt of the Phase I Inspection Report.

(d) Need for Additional Investigation

Additional investigations are required as recommended in Paragraph 7.2.

7.2 Recommendations

It is recommended that the services of a registered professional engineer be retained for the following:

(1) Rehabilitate the sluice gate structire, including the gate and operating mechanism, to serve its intended function.

(2) Repair eroded and spalled concrete on all facing walls, abutment structures, and at the spillway.

(3) Monitor the seepage at the penstock and right abutment section and determine the necessary remedial measures.

APPENDIX A

VISUAL INSPECTION CHECKLIST

INSPECTION TEAM ORGANIZATION

Date: November 14, 1978

NH 00355
WATER LOOM POND DAM
New Ipswich, New Hampshire
Souhegan River
NHWRB 175.09

Weather: Overcast, windy, $50^{\circ}F$

INSPECTION TEAM

Nicholas Campagna	Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZD)	Team Captain
Robert Minatoli	GZD	Soils
Andrew Christo	Andrew Christo Engineers (ACE)	Structural
Paul Razgha	ACE	Concrete
Richard Laramie	Resource Analysis	Hydrology

The inspection team was accompanied by Mr. Roger Laferriere, the plant manager for Warwick Mills, his plant engineer, and Mr. Pattu Kesavan of the New Hampshire Water Resources Board.

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Upstream concrete facing (cont.)		
Spalling	RR	Extensive over entire face of wall up to 2 inches deep. Top of wall exhibits surface spalls over 5% of its surface area.
Cracking		Considerable random cracking on face of wall exclusive of areas eroded or spalled. Top of walls exhibits a high degree of random cracking
Rusting and staining of Concrete		At water line where reinforcing is exposed.
Visible Reinforcing		Exposed at water line over 25% of length of wall
Efflorescence	RR	Localized
OUTLET WORKS		
A. Left Spillway Abutment and Downstream Training Wall		
Condition of Concrete	AC	Poor
Erosion		Interface between spillway crest eroded up to 6 inches deep
Spalling		Extensive over 50% of its vertical face. Top surface spalled in excess of 25% of its area
Cracking	AC	Considerable random cracking on face of concrete

CHECK LISTS FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITION & REMARKS
Rusting or staining of concrete	AC	Downstream portion of abutment stained
Visible reinforcing		None noted
[illegible] presence		Located at most of cracks
Dry stone masonry training wall		Good condition
Seepage		None noted
[illegible]. Spillway Structure		
Condition of concrete		Surface erosion
Erosion		Two locations at its base severely eroded. 16 S.F. x 6 inches deep and 8 S.F. x 3 inches deep. Various isolated eroded pockets
Cracking		Open construction joints
Rusting and staining of concrete		None noted
Visible reinforcing		None noted
Seepage		None noted
[illegible] Abutment Structure		
Condition of concrete		Poor
Erosion	AC	Interface between spillway crest eroded 9 to 12 inches deep. Upstream face eroded up to 15 inches at water line

WATER LOOM POND DAM
New Ipswich, NH

November 14, 1978
NH 00355

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Spalling	AC	Vertical faces spalled 4 inches deep over approximately 50% of surface area
Cracking		Prevalent over remaining surfaces of structure.
Rusting or staining of concrete		Minor staining at base of abutment
Visible reinforcing		None noted
Efflorescence		Located at most cracks
Seepage	AC	At base of downstream end of abutment at rate of 1 gpm
2. Gate Structure		
Timber sluice gate	PR	Gate and stem completely deteriorated. Seepage at the approximate rate of 15 to 20 gpm flows through and around gate
Operating mechanism		Non-functioning
Condition of concrete		Poor
Erosion		Extensive at base of side walls
Spalling		Side walls and upstream face severely spalled
Cracking		Extensive on side walls
Rusting or staining of concrete	PR	None noted

WATER LOOM POND DAM
New Ipswich, NH

November 14, 1978
NH 00355

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Visible reinforcement	RK	None noted
Efflorescence		Roof of outlet structure completely [illegible] with [illegible] formation
Seepage		See notation under "[illegible] Sluice Gate"
Stone masonry		Dislodged upstream [illegible] gate, entrance [illegible]
RIGHT [illegible] WALL		
Condition of concrete		Poor
Spalling		Top and upstream face severely spalled
Cracking		Considerable on top and front face
Rusting or staining of concrete		None noted
Visible reinforcement		None noted
Efflorescence		At cracks
Seepage		None noted
[illegible]		
[illegible]		Posted. Filled with earth [illegible] embankment
[illegible]		Pipe on right [illegible] filled approximately [illegible] inches
Seepage	RK	At the rate of 1 [illegible] of left embankment

[illegible]

November 11, 1978
NH 00355

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
[illegible]		
Slope conditions	NAC	Steep slopes on left side; moderate slopes on right side; heavy vegetation on both sides
[illegible] slides or falls		None noted
[illegible] debris		Trees and branches in channel and along the bank
[illegible] overhanging the channel		Heavy overgrowth on both sides of channel does extend over channel; some vegetation growing in the channel
Other obstructions		Six-foot diameter penstock spans channel 75 feet downstream of dam. Bottom of penstock approximately 7 feet above channel bottom
[illegible]		None
[illegible]		
[illegible]		
[illegible]		None noted
[illegible]		[illegible] appear [illegible]
[illegible]		[illegible] behind [illegible]
[illegible]		[illegible]
[illegible]	NAC	

APPENDIX C

SELECTED PHOTOGRAPHS

The New Hampshire Water Resources Board (NHWRB), 37 Pleasant Street, Concord, NH 03301, maintains an extensive correspondence file for Water Loom Pond Dam. Included in this file are several inspection reports, inventory reports, questionnaires, and correspondence relating to the dam. Some of the more pertinent data contained in the file are listed below.

1. NHWRB Dam Safety Inspection Report dated Sept. 21, 1971.

2. New Hampshire Water Control Commission (NHWCC) Report on Dam Inspection dated July 3, 1951.

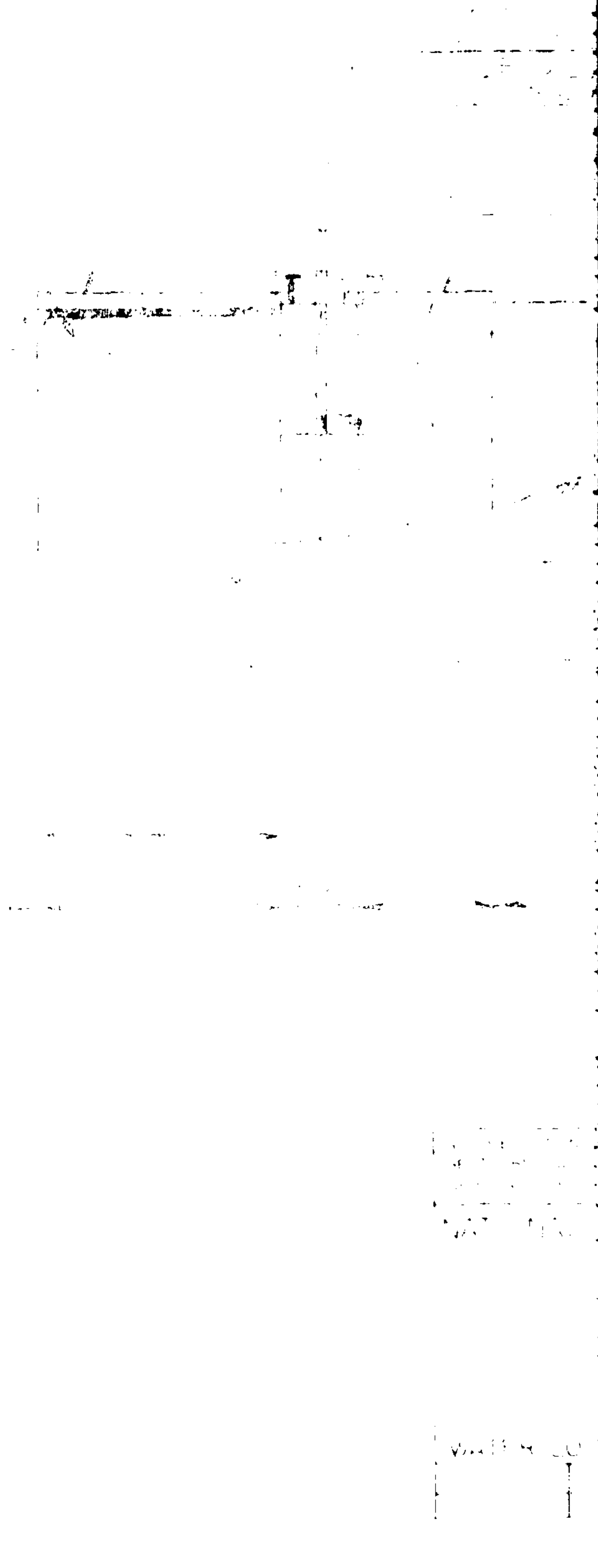
3. Letter from Greenville Mills Engineering Department to NHWRB regarding power generation at several [illegible] dated April 16, 1937.

4. NHWRB Data [illegible] New Hampshire dated April [illegible]

5. NHWRB [illegible] Water Power Developments in New Hampshire dated April 17, 1939.

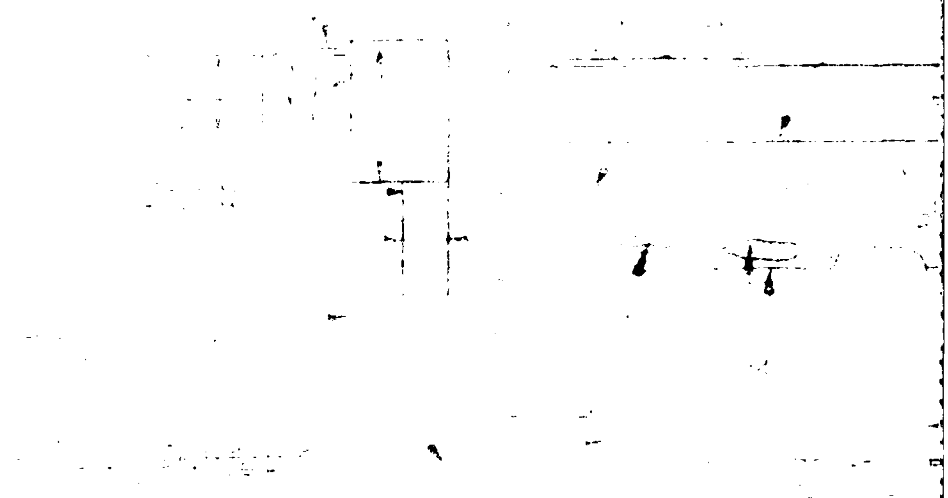
6. NHWRB [illegible] 1938 with response [illegible]

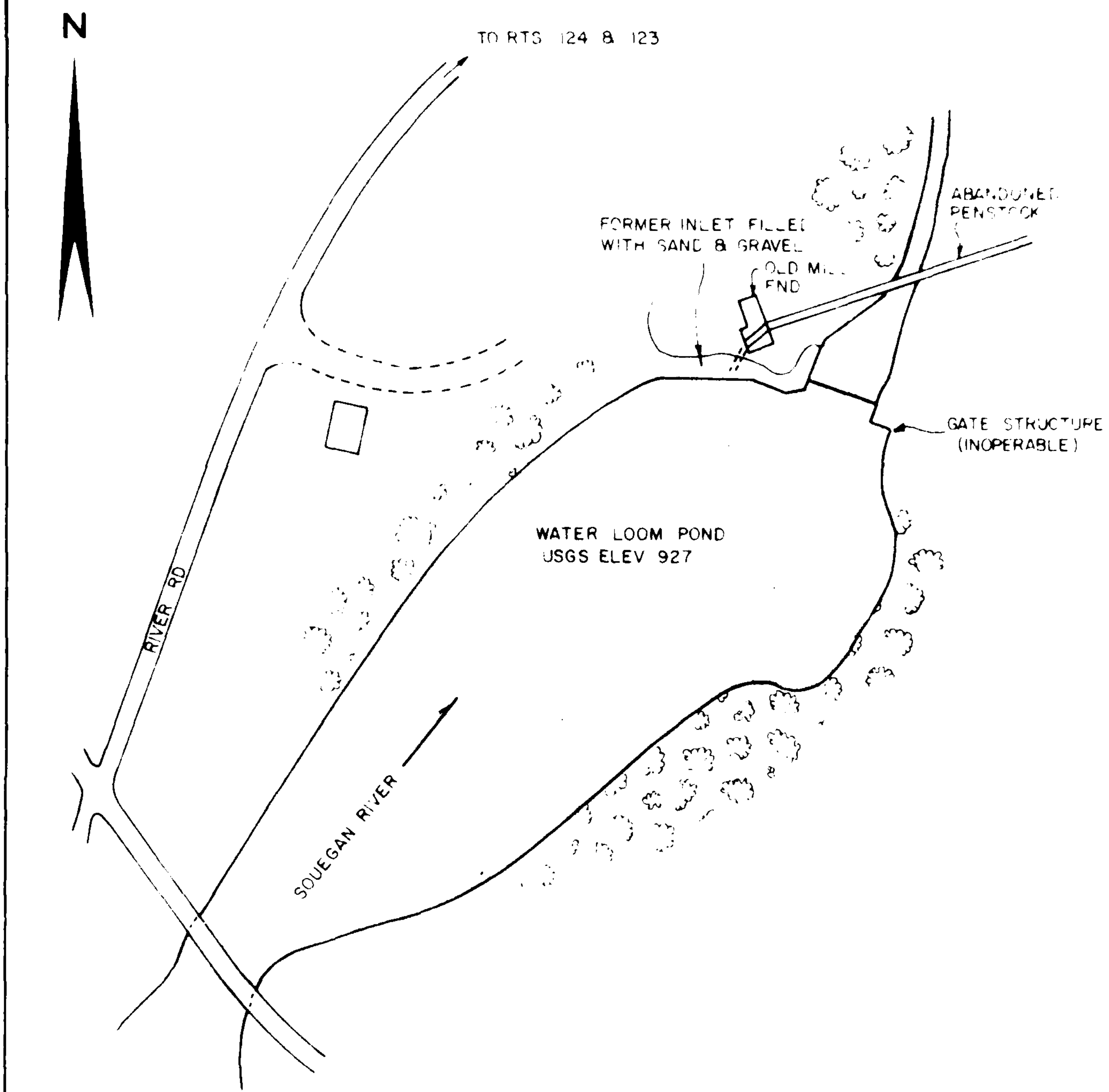
7. NHWRB Inventory [illegible] Water Power Developments [illegible] 1937



[illegible]

PLAN AND SECTION





GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

SITE PLAN

FILE No. 2201

WATER LOOM POND DAM — NEW HAMPSHIRE

SCALE 1" ≈ 200'

DATE NOVEMBER 1978

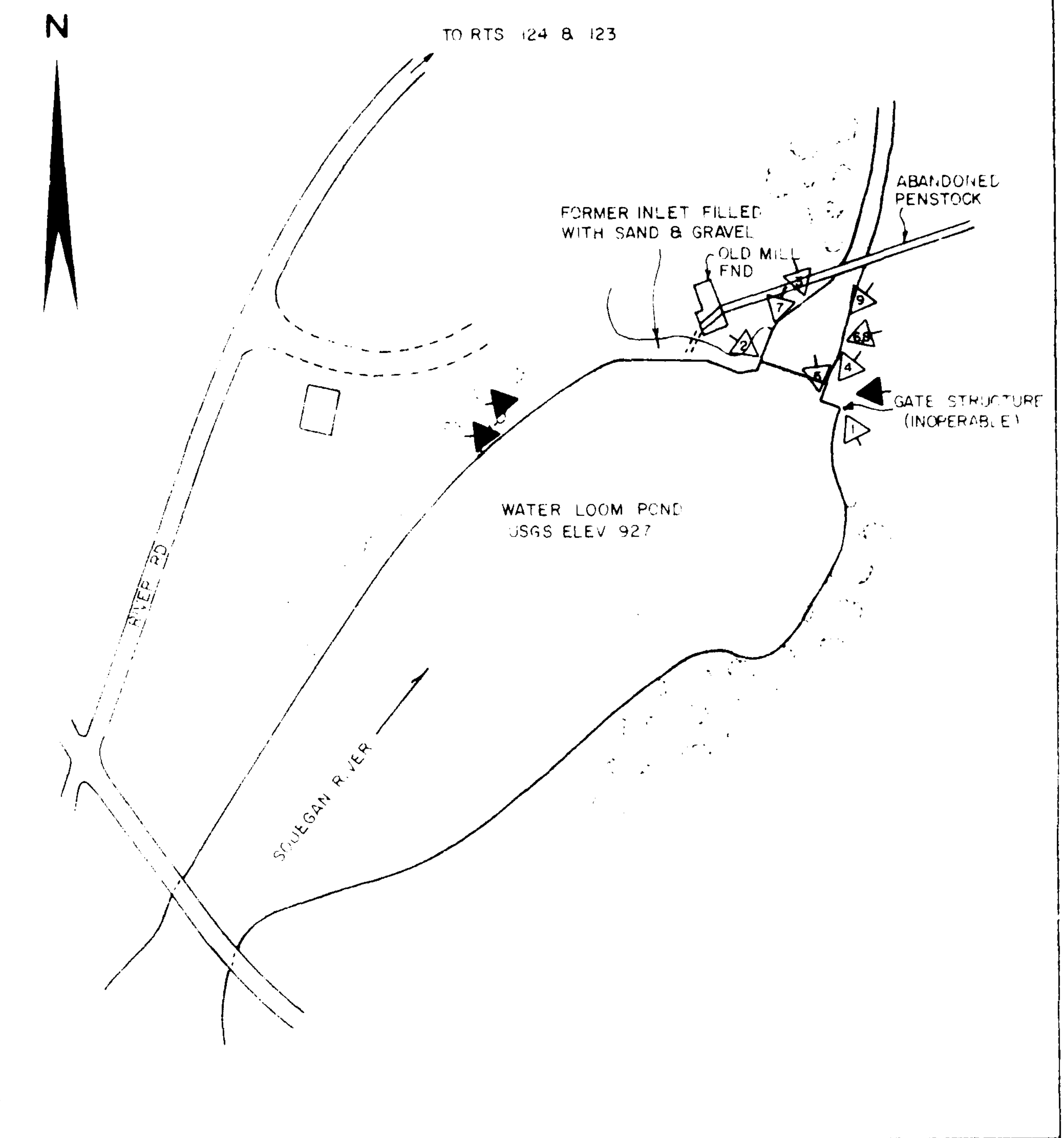
APPENDIX B

WATER LOOM POND DAM
New Ipswich, NH

November 14, 1979
NH 00355

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
OPERATION AND MAINTENANCE FEATURES		
A. Reservoir regulation plan	RAC	None exists
B. Maintenance	RAC	Considerable repairs and maintenance needed at dam



GOLDBERG, ZOINO, DUNNICLIFF & ASSOC. INC
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS

U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LOCATION AND ORIENTATION OF PHOTOS

WATER LOOM POND DAM — NEW HAMPSHIRE

SCALE ≈ 200'

DATE NOVEMBER 1979

1. View of downstream channel from right abutment showing penstock

2. View of right abutment from left side of spillway showing bedrock outcrops at abutment and under spillway

3. View of right abutment from downstream showing deterioration of concrete

1. View from downstream showing sluiceway with non-operational gate on upstream face of dam and deteriorated concrete of right abutment

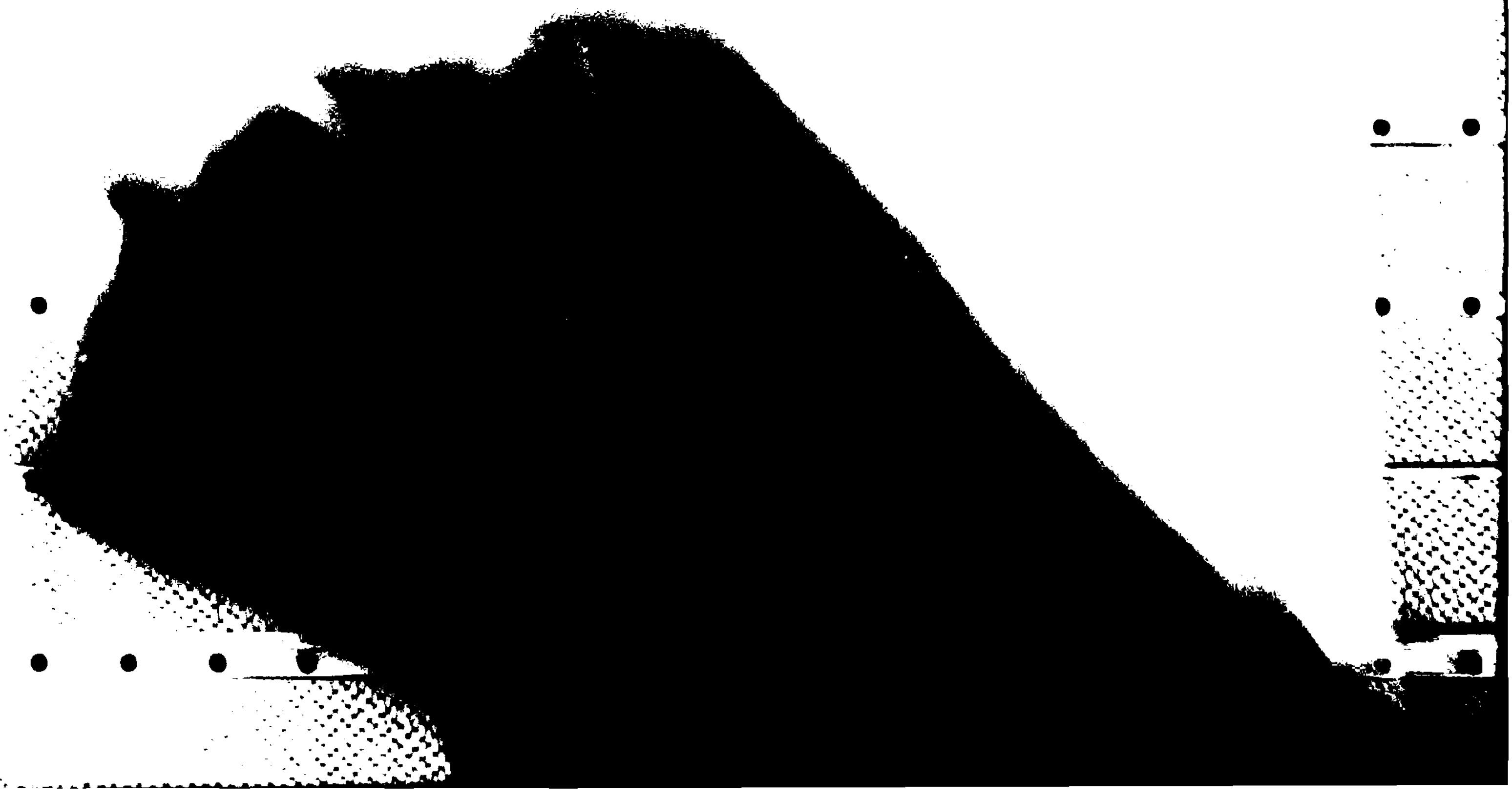
5. View of deteriorated condition of gate operating mechanism

6. View of left spillway endwall from downstream showing deteriorated concrete

7 View from downstream showing earth filled rock crib forming left side of dam

[illegible] way from downstream showing [illegible] on concrete facing

9. Detail of deteriorated concrete on downstream side of spillway



APPENDIX D

HYDROLOGIC/HYDRAULIC COMPUTATIONS

I Dam Rating Curve

Some of the physical characteristics of the Miller Lean Pond dam, spillway, and outlet are shown in the schematic sketch on page 2. Based on the ... survey file and recent field inspection. From these we developed stage-discharge relations for the dam.

Datum -- spillway crest, elev. 927.7

Ogee Spillway

$Q_1 = CL H_1^{1.5}$ $\qquad \dfrac{3.7 \times 15 \times H^{1.5}}{\text{see ...}}$

$C = 3.7$

$L = 15$

$H_1 = H$

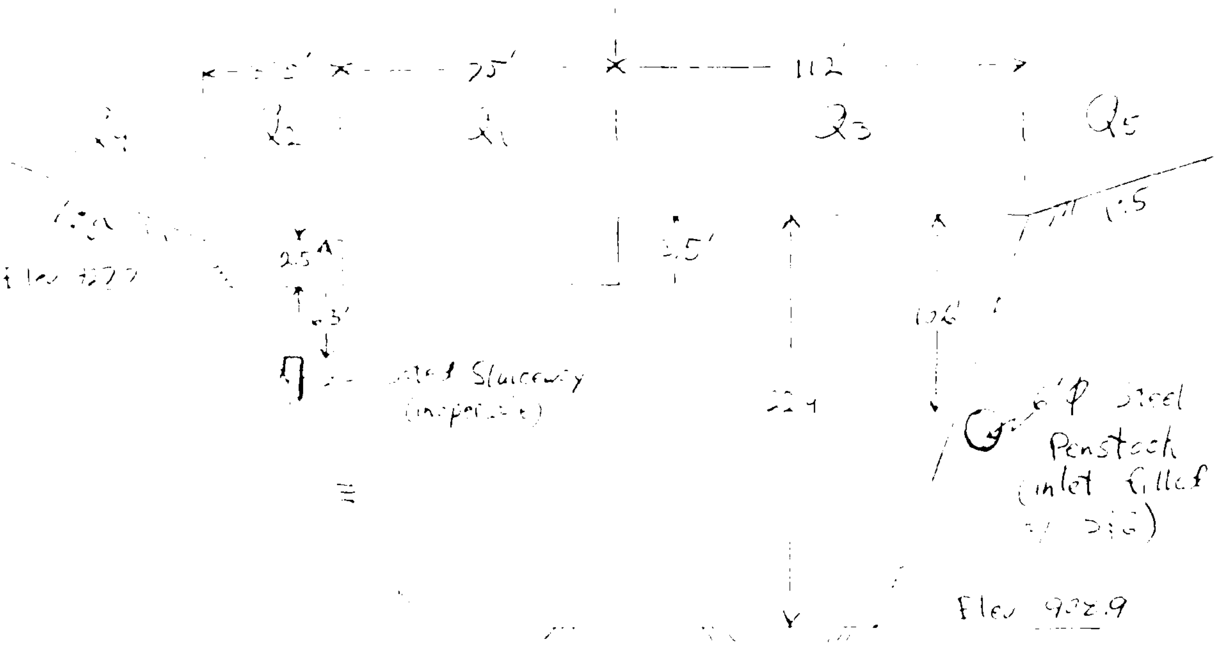
L.S. Dam

$Q_2 = CL H_2^{1.5}$ $\qquad \dfrac{2.6 \times 375 \times (H-2.5)^{1.5}}{\text{...}}$

$C = 2.6$

$L = 375$

$H_2 = H-2.5$ $\qquad$ (at elev. 930.2)



Schematic Cross-Section
Water Lane Pond Dam

(looking upstream)

[illegible] Dam Safety [illegible] Lower Lam [illegible] Dam KAE 2-[illegible]-[illegible] [illegible]

[illegible] Dam

$Q_3 = C\,L\,H_3^{1.5} = 2.0 \times 112 \times (H-3.5)^{1.5}$

$C = 2.8$ (overgrown broad-crested weir)

$L = 112$

$H_3 = H - 3.5$ (crest elev [illegible])

[illegible] Abutment

$Q_4 = C\,L\,H_4^{1.5} = 2.8 \times (H-2.5) \times 5 \times ((H-2.5)/2)^{1.5}$

$C = [illegible]$

$L = (H-2.5) \times 5$ (1:5 slope)

$H_4 = H - 2.5/2$ (avg. height)

[illegible] Abutment

$Q_5 = C\,L\,H_5^{1.5} = 2.5 \times (H-3.5) \times 5 \times ((H-3.5)/2)^{1.5}$

$C = 2.5$

$L = (H-3.5) \times 5$ (1:5 slope)

$H_5 = H - 3.5/2$ (avg. height)

[illegible]

$Q_6 = 0$ (impossible)

[illegible] (impossible)

A [illegible] program was written to calculate an [illegible] [illegible] stage discharge function of the dam. A listing is shown in [illegible] followed by [illegible] output [illegible] [illegible] [illegible].

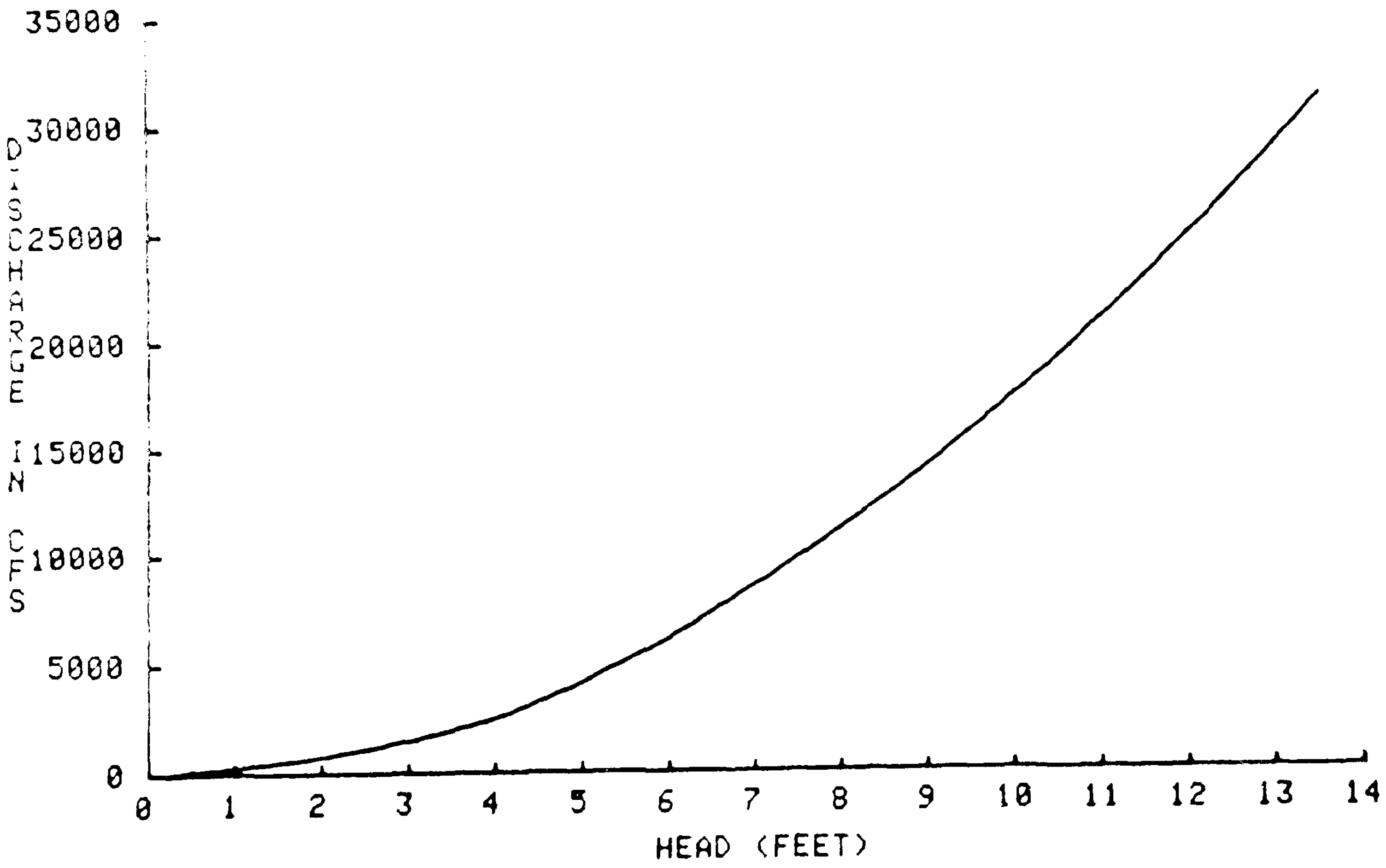
[illegible]

```
LIST
100 REM: STAGE DISCHARGE PROGRAM FOR WATER LOOM POND DAM
110 REM: PROGRAM STORED ON TAPE 18, FILE 51
120 PAGE
130 PRINT "DISCHARGE FROM WATER LOOM POND DAM AS A FUNCTION OF HEAD"
140 PRINT USING 150:
150 IMAGE //2T"HEAD"30T"DISCHARGE"
160 PRINT USING 170:
170 IMAGE 1T"(FEET)"32T"(CFS)"
180 PRINT USING 190:
190 IMAGE 10T"SLUICEWAY"5X"PENSTOCK"5X"SPILLWAY"5X"TOP OF DAM"5X"TOTAL"
200 FOR H=0 TO 13.5 STEP 0.5
210 Q1=3.7*75*H↑1.5
220 Q2=0
230 Q3=0
240 Q4=0
250 Q5=0
260 Q6=0
270 Q7=0
280 IF H<=2.5 THEN 340
290 Q2=2.8*37.5*(H-2.5)↑1.5
300 Q4=2.8*(H-2.5)*5*(0.5*(H-2.5))↑1.5
310 IF H<=3.5 THEN 340
320 Q3=2.8*112*(H-3.5)↑1.5
330 Q5=2.8*(H-3.5)*5*(0.5*(H-3.5))↑1.5
340 T1=Q2+Q3+Q4+Q5
350 T2=Q1+T1
360 PRINT USING 370:H,Q6,Q7,Q1,T1,T2
370 IMAGE 2T,2D.1D,9D,13D,16D,14D,11D
380 NEXT H
390 END
```

DISCHARGE FROM WATER LOOM POND DAM AS A FUNCTION OF HEAD

HEAD (FEET)	DISCHARGE (CFS) SLUICEWAY	PENSTOCK	SPILLWAY	TOP OF DAM	TOTAL
0.0	0	0	0	0	0
0.5	0	0	98	0	98
1.0	0	0	278	0	278
1.5	0	0	510	0	510
2.0	0	0	785	0	785
2.5	0	0	1097	0	1097
3.0	0	0	1442	38	1480
3.5	0	0	1817	110	1927
4.0	0	0	2220	319	2538
4.5	0	0	2649	644	3293
5.0	0	0	3103	1054	4156
5.5	0	0	3579	1538	5117
6.0	0	0	4078	2089	6169
6.5	0	0	4599	2705	7304
7.0	0	0	5139	3382	8521
7.5	0	0	5700	4118	9818
8.0	0	0	6279	4912	11191
8.5	0	0	6877	5763	12639
9.0	0	0	7492	6669	14162
9.5	0	0	8125	7632	15757
10.0	0	0	8775	8649	17425
10.5	0	0	9442	9722	19163
11.0	0	0	10124	10848	20972
11.5	0	0	10822	12030	22852
12.0	0	0	11535	13265	24801
12.5	0	0	12264	14556	26820
13.0	0	0	13007	15900	28907
13.5	0	0	13765	17299	31064

STAGE-DISCHARGE CURVE AT WATER LOOM POND



[illegible]

[illegible] reduced

[illegible]

[illegible] essentially

[illegible] portion of [illegible]

Dam Safety Water Lon Road Dam

High Bridge

Constructed High Bridge

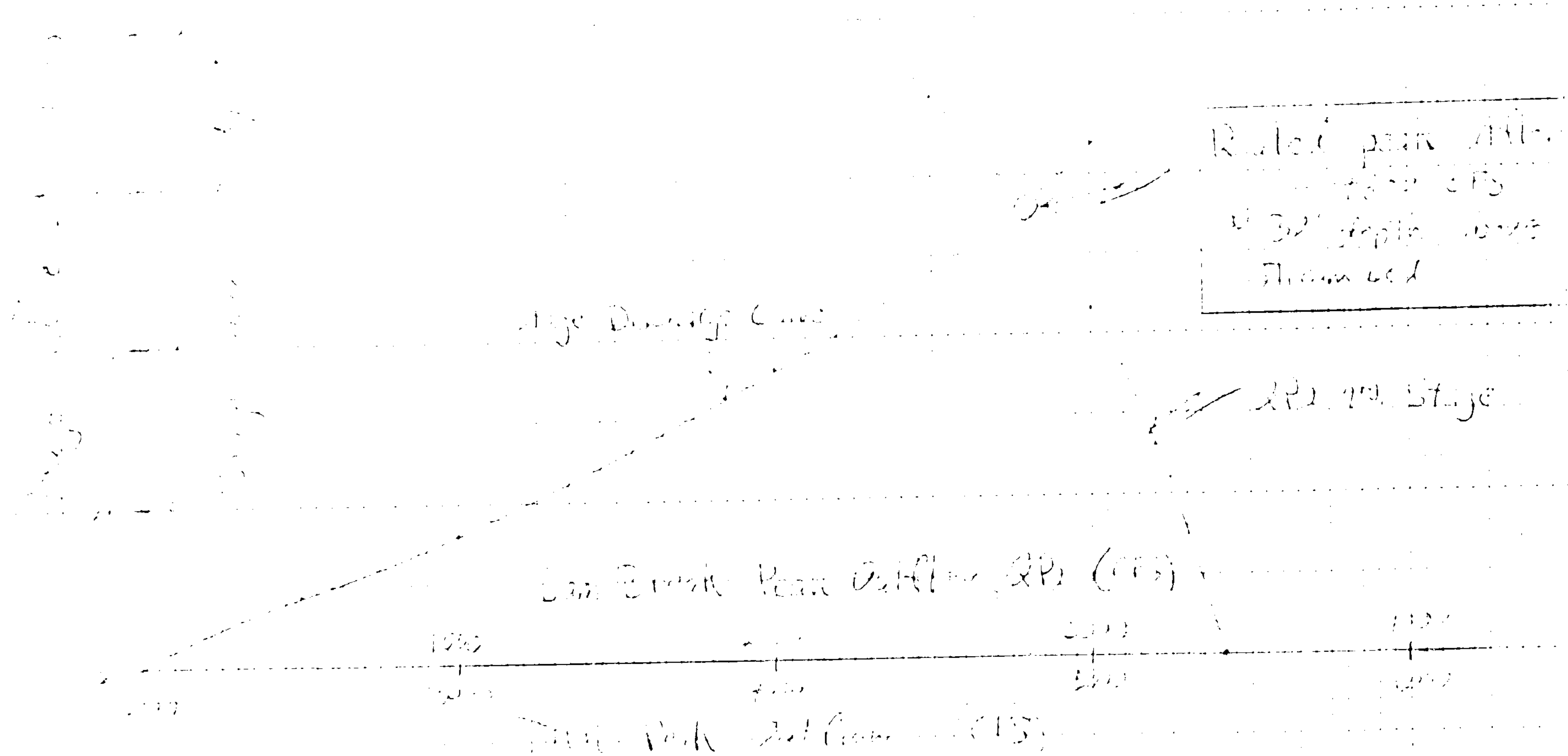
these conditions

[illegible] ** Dam Safety Cedar Lake Pond Dam [illegible]

Peak Total Outflow from High Bridge

= 2800 + 2000 = 4800 CFS

It does not appear that [illegible] water [illegible] High Bridge [illegible]



Dam Safety Water Loom Pond Dam [illegible] 2-?-79 4/

Routing equation

$$QP_2 = QP_1\left(1 - \frac{V'}{S}\right)$$

QP_2 = routed outflow peak of dam break wave

QP_1 = [illegible] CFS (dam break component peak inflow)

S = [illegible] AF (total volume of dam break wave)

$V' = [illegible]\left(1 - \frac{QP_2}{[illegible]400}\right)$ (surcharge storage vol. required to reduce outflow peak to QP_2)

QP_2	[illegible]	Stage
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible] Dam Safety Water Lawn Pond Dam [illegible] 2-7-77 15/[illegible]

[illegible]

[illegible] U.S.C.E. Rule of Thumb [illegible] with the [illegible] assumptions and modifications.

- [illegible] steady flow component [illegible] [illegible] [illegible] the [illegible] [illegible] superimposed.
- Only the [illegible] component is routed. [illegible] reduced by [illegible] steady water [illegible] added [illegible] steady flow [illegible] the [illegible]
- The [illegible] the [illegible] flood [illegible] the [illegible] water Lawn Pond [illegible]

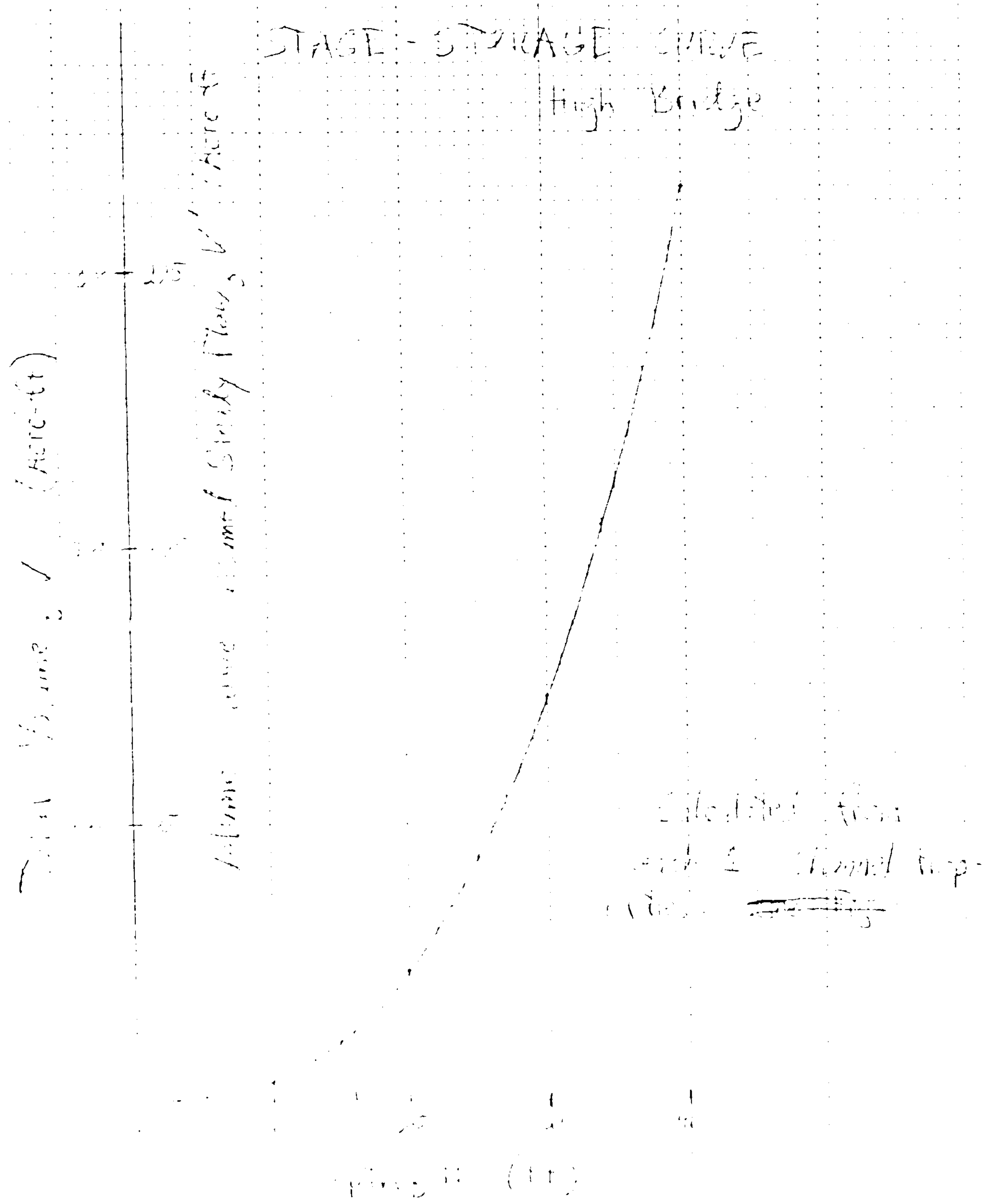
[illegible] steady flow component conditions [illegible] [illegible] [illegible] time [illegible] failure

[illegible] CFS [illegible] storage [illegible] [illegible] water Lawn [illegible] [illegible]

[illegible] [illegible] storage [illegible] large [illegible] [illegible]

[illegible] [illegible] [illegible]

[illegible] [illegible]


STAGE - STORAGE CURVE
High Bridge
(acre-ft)
225

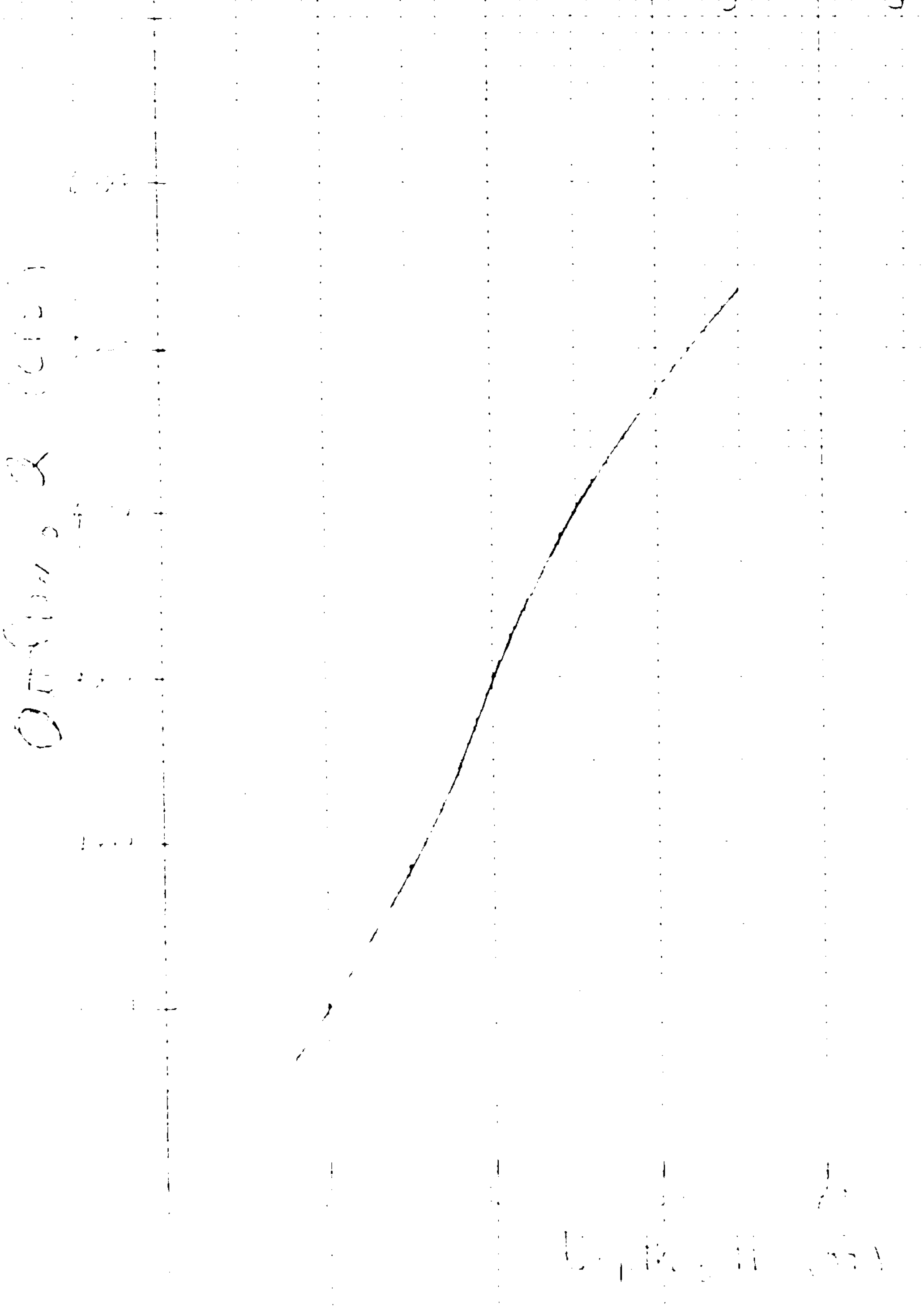
Job # 105 Dam Safety Water [illegible] Pond Dam 2-7-79 13/32

[illegible] Storage @ High Bridge

H	Area	Avg. Area	Length	Δ Vol	Vol
0	0				0
		13.8	110	.03	
1	22.5				.03
⋮	⋮	⋮	⋮	⋮	⋮
15	[illegible]				[illegible]
		[illegible]	110	[illegible]	
[illegible]	[illegible]				[illegible]
		[illegible]		[illegible]	
[illegible]	[illegible]				[illegible]
		[illegible]		[illegible]	
[illegible]	[illegible]				[illegible]
		[illegible]		[illegible]	
[illegible]	[illegible]				[illegible]
		[illegible]		[illegible]	
[illegible]	[illegible]				[illegible]
		[illegible]		[illegible]	
[illegible]	[illegible]				[illegible]
		[illegible]		[illegible]	
[illegible]	[illegible]				[illegible]
		[illegible]		[illegible]	
[illegible]	[illegible]				[illegible]
		[illegible]		[illegible]	
[illegible]	[illegible]				[illegible]
		[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]				[illegible]
		[illegible]		[illegible]	
[illegible]	[illegible]				[illegible]
				[illegible]	
[illegible]	[illegible]				[illegible]
[illegible]	[illegible]				[illegible]
					[illegible]

13/32

STAGE-DISCHARGE CURVE
High Bridge



• [illegible] box culvert is roughly equivalent to the real structure

H	Q
5	[illegible]
12	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]60

[illegible] Stage [illegible] Page [illegible] [illegible] behind [illegible] Bridge [illegible] estimated from the Reach I channel properties

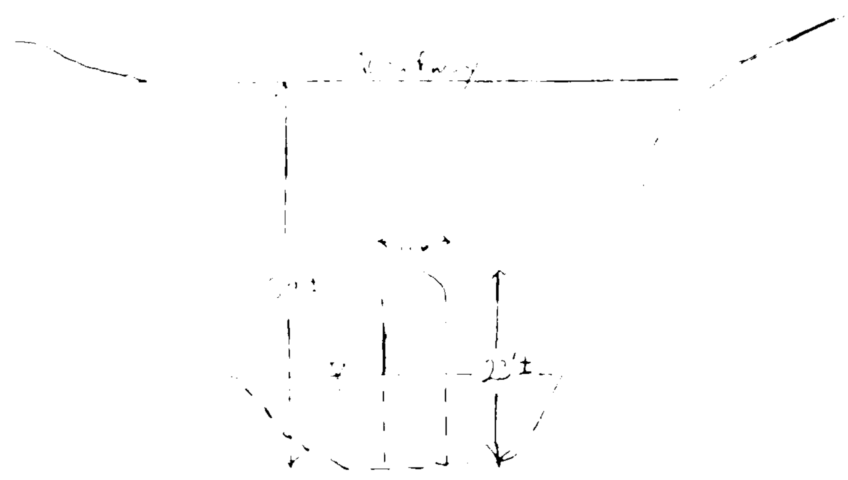
slope $= \frac{1' \text{ rise}}{110' \text{ run}}$

[illegible]

[illegible]

Job # 165 Dam Safety [illegible] Lan Pond Dam [illegible] 7-77 10/32

High Bridge [illegible] ([illegible])



High Bridge Configuration

[illegible] perform the routing, a stage storage [illegible] and a stage discharge curve need to be [illegible] at High Bridge

[illegible] Discharge Curve — Page [illegible]

- [illegible] below [illegible], the [illegible] [illegible] tailwater and [illegible] are [illegible].
- [illegible] inlet control is assumed and [illegible] are [illegible] from the equation

[illegible] 11.7834 [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

DEPTH	ELEV	AREA	WPER	HYD-R	AR2/3	Q
0.0	900.0	0.0	0.0	0.0	0.0	0.0
1.0	901.0	27.5	30.4	0.9	25.7	92.4
2.0	902.0	60.0	35.8	1.7	84.7	304.3
3.0	903.0	97.5	41.2	2.4	173.3	622.6
4.0	904.0	140.0	46.5	3.0	291.8	1048.4
5.0	905.0	205.0	86.6	2.4	364.3	1308.5
6.0	906.0	295.0	96.8	3.0	620.4	2228.5
7.0	907.0	395.0	107.0	3.7	944.0	3391.0
8.0	908.0	505.0	117.2	4.3	1338.0	4806.4
9.0	909.0	625.0	127.4	4.9	1805.6	6486.2
10.0	910.0	755.0	137.6	5.5	2350.3	8442.8
11.0	911.0	895.0	147.8	6.1	2975.5	10688.7
12.0	912.0	1045.0	158.0	6.6	3684.7	13236.5
13.0	913.0	1205.0	168.2	7.2	4481.5	16098.7
14.0	914.0	1375.0	178.4	7.7	5369.3	19287.8
15.0	915.0	1555.0	188.6	8.2	6351.4	22816.1
16.0	916.0	1745.0	198.8	8.8	7431.5	26695.7
17.0	917.0	1945.0	209.0	9.3	8612.7	30938.9
18.0	918.0	2155.0	219.2	9.8	9898.3	35557.4
19.0	919.0	2375.0	229.4	10.4	11291.8	40563.0
20.0	920.0	2605.0	239.6	10.9	12796.2	45967.2
21.0	921.0	2845.0	249.8	11.4	14414.8	51781.7
22.0	922.0	3095.0	260.0	11.9	16150.7	58017.6
23.0	923.0	3355.0	270.2	12.4	18007.1	64686.1
24.0	924.0	3625.0	280.4	12.9	19987.0	71798.3
25.0	925.0	3905.0	290.6	13.4	22093.4	79365.2

REACH#1 - WATER LOOM POND

1/32

165 Dam Safety Water Loom [illegible] Dam VIII #7 17 8/[illegible]

$Q = \frac{2}{3} \cdot 130 \cdot \sqrt{3} \cdot [illegible]^{3/2} = 341 \; CFS$

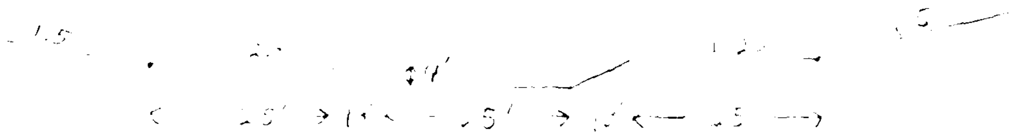
use 342 CFS

Downstream Flooding

Reach 1

Reach 1 extends from the dam [illegible] downstream to High Bridge. [illegible] channel properties and cross section [illegible] are [illegible] below.

[illegible] $n = .04$, $S = .007$



A simple BASIC program was used to calculate [illegible] rating table and other channel properties, shown on the following page.

[illegible] there are no structures endangered or [illegible] along this reach the calculations were made to estimate the tailwater at dam failure and to estimate the [illegible] stage [illegible] behind High Bridge (next paragraph)

[illegible]

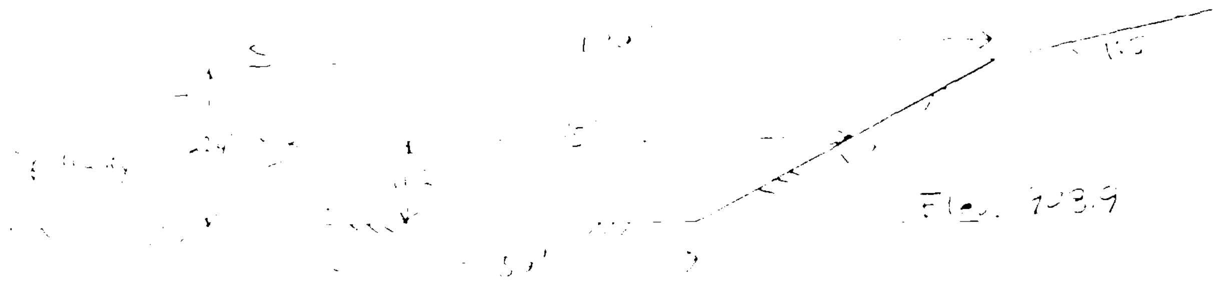
[illegible] the bridge [illegible]

CE 103 Dam Safety   Water Loom Pond Dam   LHF 2-7-79   7/[illegible]

II Dam Failure Analysis

Because the spillway and R.S. of the dam are solid concrete structures founded on rock, it will be assumed that the critical failure section will be the L.S. of the dam and the critical pool elevation will be that which just overtops this section, elev. 70[illegible] (H = 5.6'). A simplified view of this section* is sketched below.

* looking upstream



Elev. 7?3.9

Volume of flow at overtopping

use Q = [illegible] 3.09 [illegible]   (from dam rating curve, rounded up from 1.52 to be conservative)

Dam breach flow

$Q = \frac{8}{27} W_b \sqrt{g}\, Y_o^{3/2}$

$W_b =$ [illegible]   (width of breach assumed 40% of dam length at 1/2 height)

[illegible] height [illegible]
[illegible]

Dam Safety [illegible] Pond Dam [illegible]

[illegible]

[illegible] Dan [illegible]

[illegible]

[illegible] program [illegible]

[illegible]

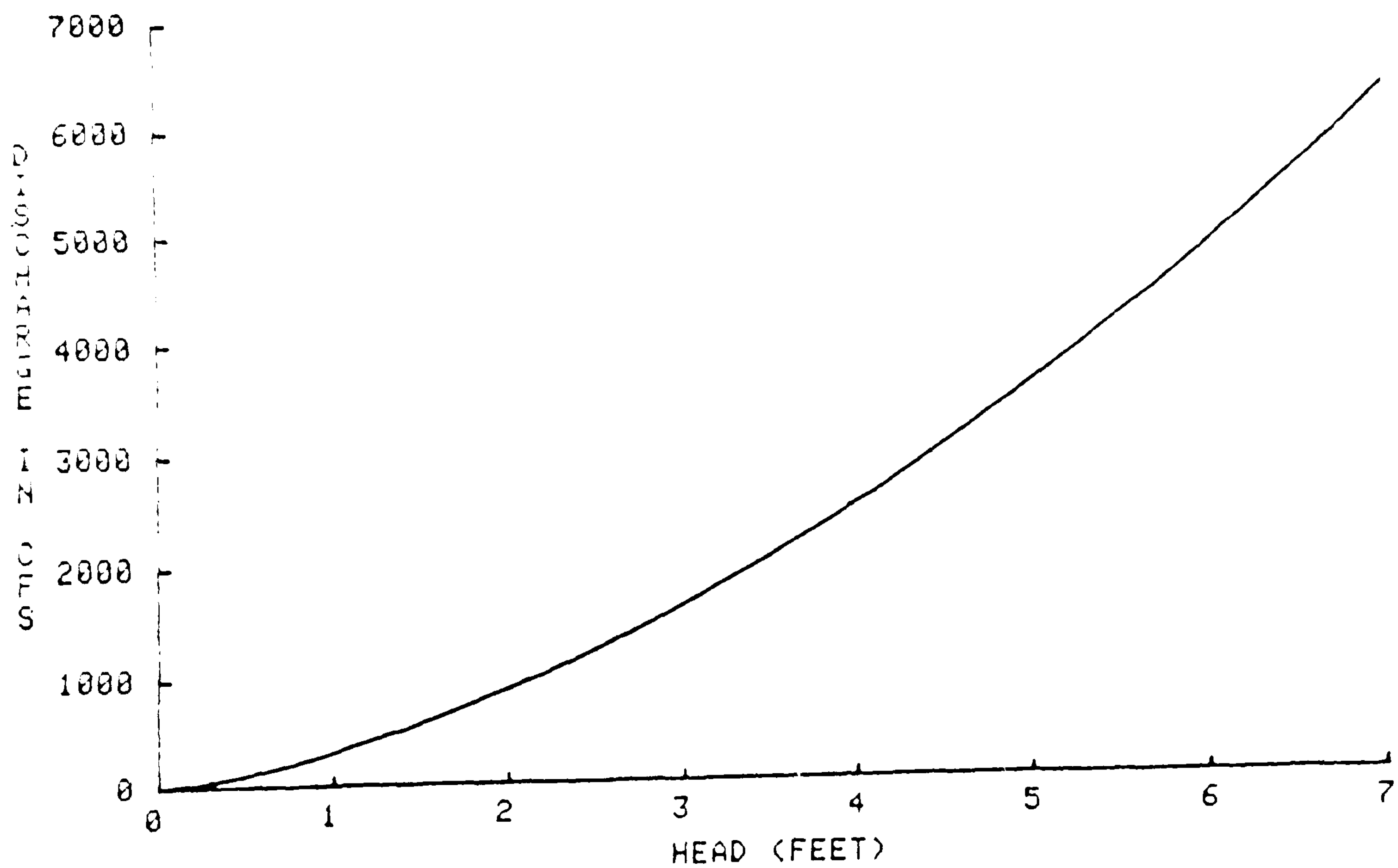
[illegible]

```
LIST
100 REM: STAGE DISCHARGE PROGRAM FOR OTIS COMPANY DAM # 1, JOB 165
110 REM: ON TAPE 10, FILE 57
120 PAGE
130 PRINT "DISCHARGE FROM OTIS COMPANY DAM # 1 AS A FUNCTION OF HEAD"
140 PRINT USING 150:
150 IMAGE // 2T"HEAD"30T"DISCHARGE"
160 PRINT USING 170:
170 IMAGE 1T"(FEET)"32T"(CFS)"
180 PRINT USING 190:
190 IMAGE 15T"TOTAL"8X"LEFT BANK"8X"RIGHT BANK"8X"SPILLWAY"
200 FOR H=0 TO 7 STEP 0.25
210 Q1=0
220 Q2=0
230 Q3=0
240 Q5=0
250 Q6=0
260 Q4=3.3*93*H↑1.5
270 IF H<=3.7 THEN 350
280 Q5=3*20*(H-3.7)↑1.5
290 IF H<=4.7 THEN 350
300 Q6=2.8*(H-4.7)*10*(0.5*(H-4.7))↑1.5
320 IF H<=6 THEN 350
330 Q3=3*8*(H-6)↑1.5
340 IF H<=7.5 THEN 350
341 Q2=2.8*40*(H-7.5)↑1.5
342 Q1=2.8*10*(H-7.5)*(0.5*(H-7.5))↑1.5
350 T1=Q1+Q2+Q3
360 T2=Q5+Q6
370 T3=T2+Q4+T1
380 PRINT USING 390:H,T3,T1,T2,Q4
390 IMAGE 2T,2D.2D,14D,15D,18D,17D
400 NEXT H
410 END
```

DISCHARGE FROM OTIS COMPANY DAM # 1 AS A FUNCTION OF HEAD

HEAD (FEET)	DISCHARGE (CFS) TOTAL	LEFT BANK	RIGHT BANK	SPILLWAY
0.00	0	0	0	0
0.25	38	0	0	38
0.50	109	0	0	109
0.75	199	0	0	199
1.00	307	0	0	307
1.25	429	0	0	429
1.50	564	0	0	564
1.75	710	0	0	710
2.00	868	0	0	868
2.25	1036	0	0	1036
2.50	1213	0	0	1213
2.75	1400	0	0	1400
3.00	1595	0	0	1595
3.25	1798	0	0	1798
3.50	2010	0	0	2010
3.75	2229	0	1	2229
4.00	2465	0	10	2455
4.25	2713	0	24	2689
4.50	2973	0	43	2930
4.75	3242	0	65	3177
5.00	3521	0	89	3431
5.25	3810	0	118	3692
5.50	4109	0	151	3959
5.75	4419	0	187	4232
6.00	4739	0	228	4510
6.25	5072	3	274	4795
6.50	5419	8	324	5086
6.75	5777	16	379	5382
7.00	6147	24	439	5684

STAGE-DISCHARGE CURVE AT OTIS COMPANY DAM # 1



[illegible] Dam Safety [illegible] VIII [illegible]

III. [illegible] Analysis

[illegible] Classification [illegible]

Storage [illegible] 1000 AF

Height [illegible]

[illegible] Hazard Classification [illegible] Significant

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] regression equations

[illegible]

[illegible]

[illegible]

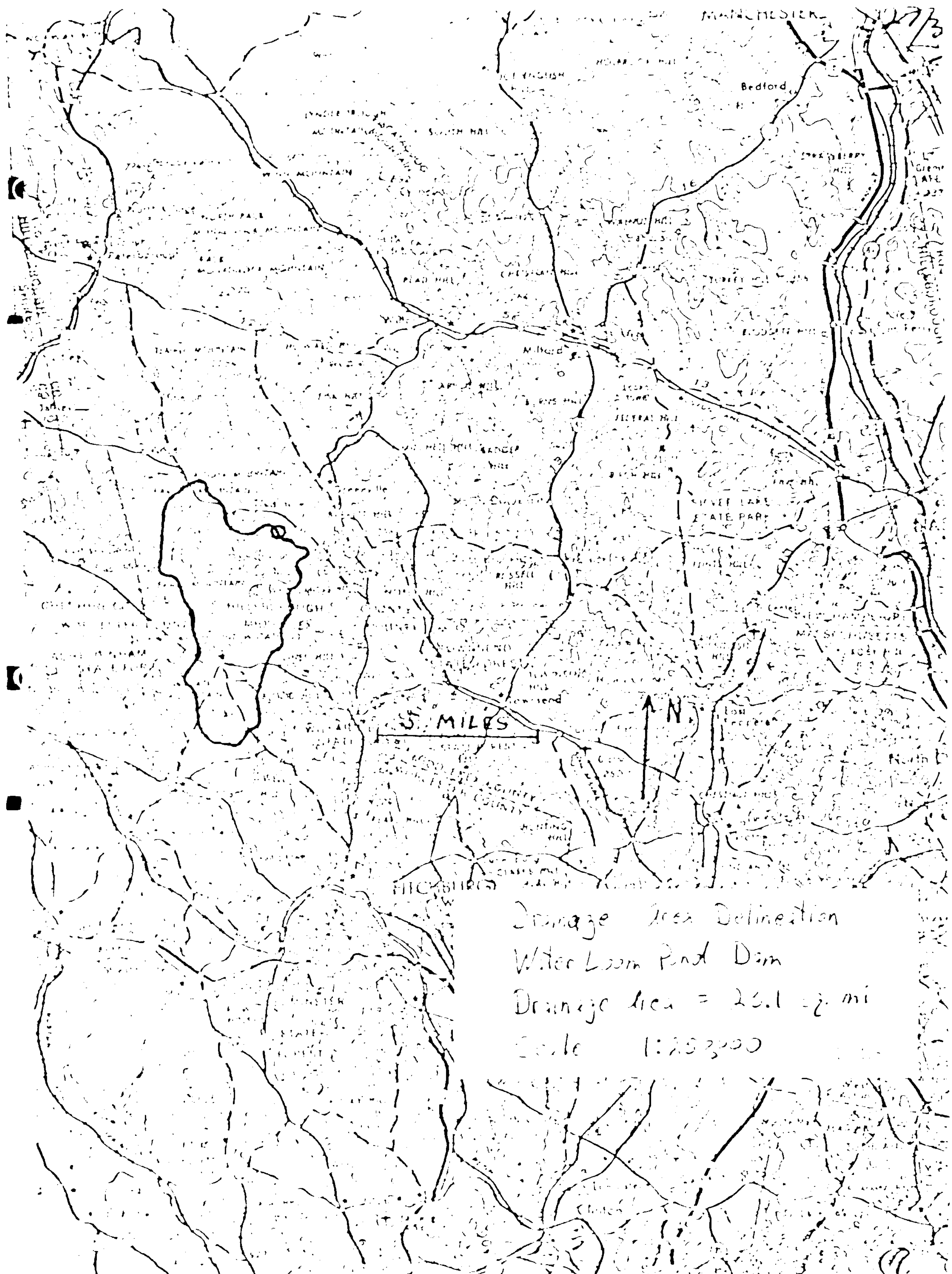
[illegible]

[illegible]

[illegible]

[illegible]

[illegible]


MANCHESTER
Bedford
Milford
SILVER LAKE STATE PARK
Townsend
5 MILES
N
Drainage Area Delineation
Water Loom Pond Dam
Drainage Area = 23.1 sq mi
Scale 1:253000

[illegible]

Historic Trends

[illegible]

[illegible]

DA [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

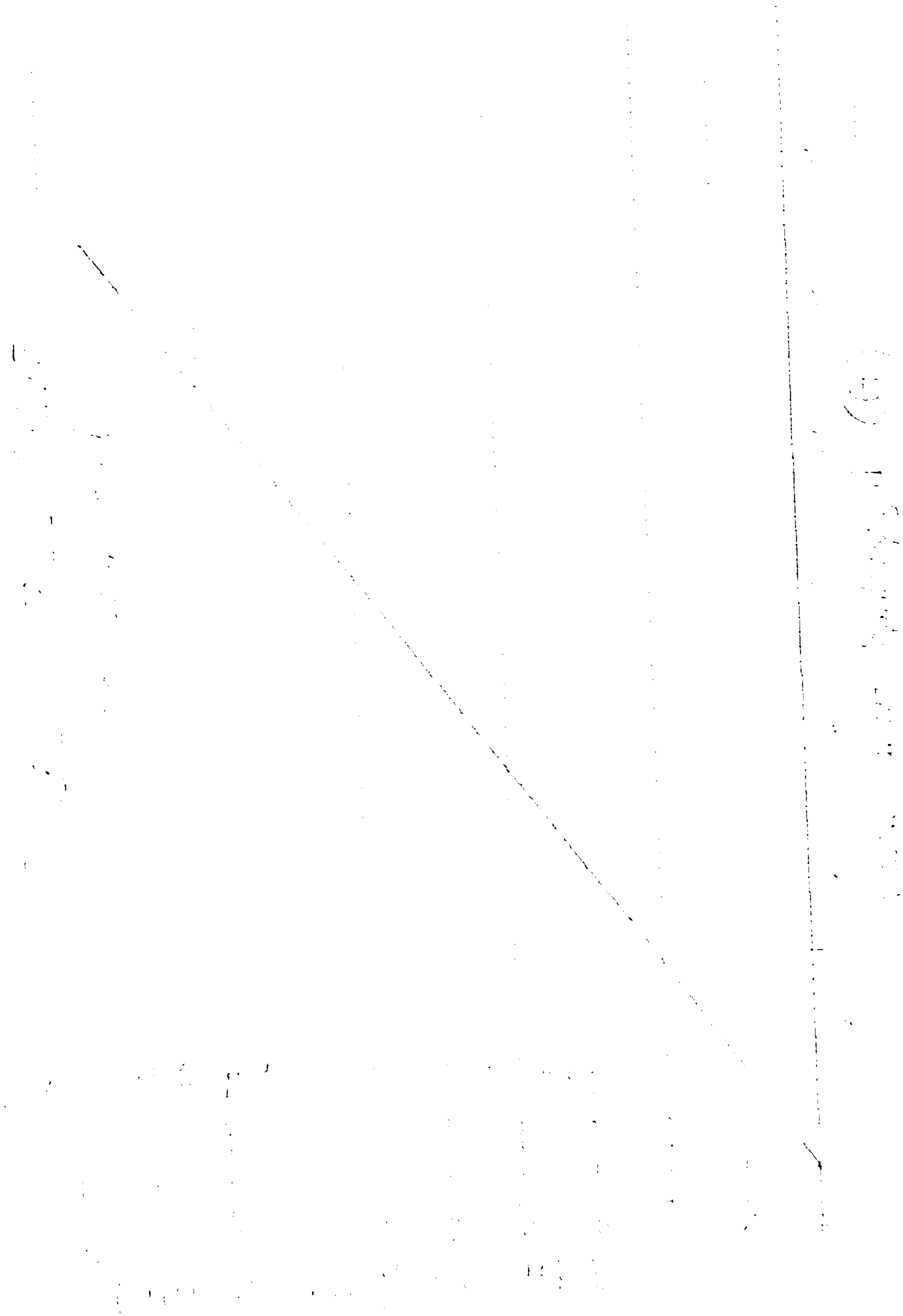
[illegible]

[illegible]

[illegible] is shown in the [illegible]

[illegible]

[illegible]



[illegible]

[illegible]

[illegible]

[illegible]

END

FILMED

8-85

DTIC